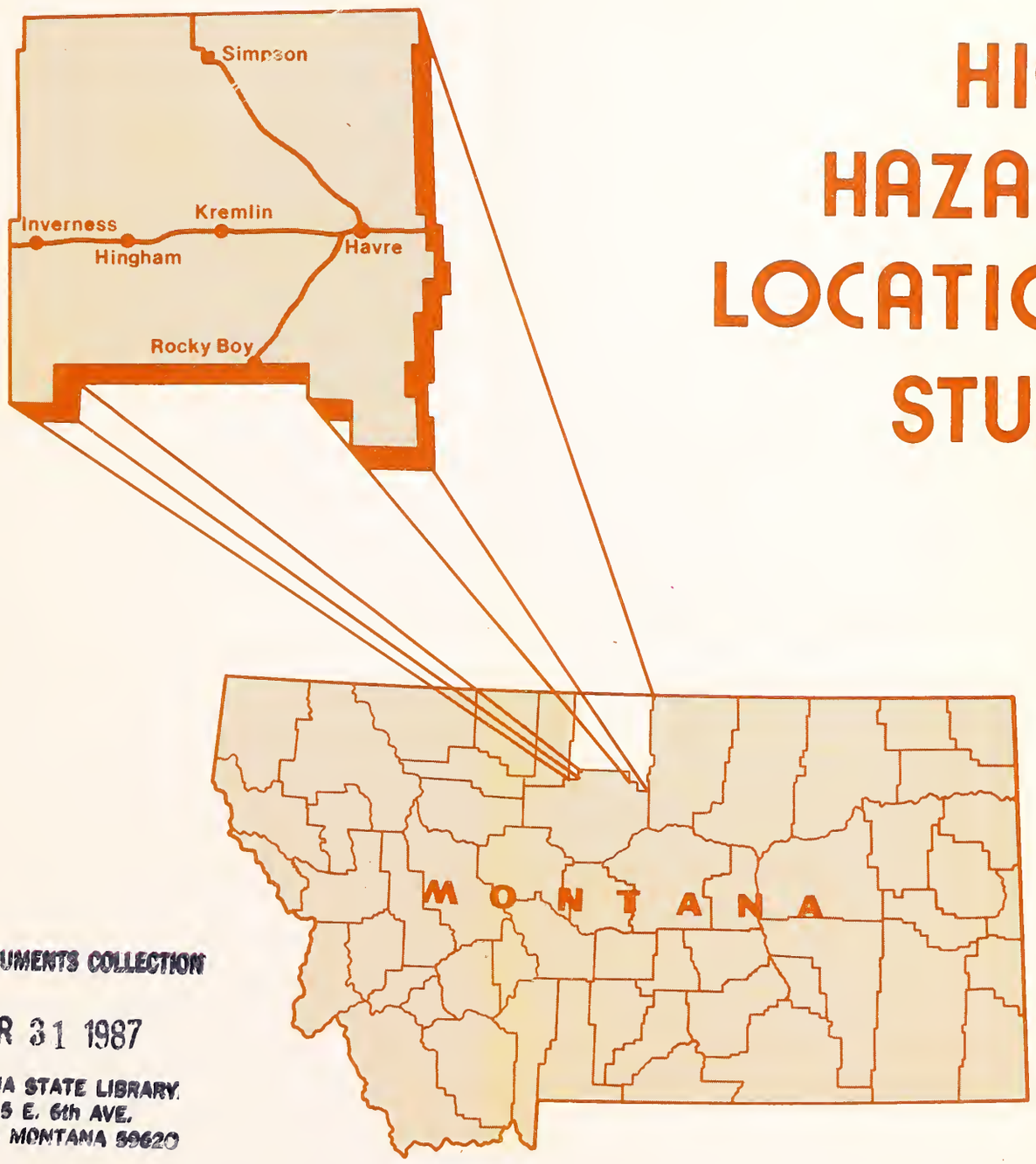
Hill County



HIGH HAZARD LOCATION STUDY

RPA Robert Peccia & Associates

December 1982

ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers
810 HIALEAH COURT
HELENA, MONTANA 59601 406/442-8160

February 25, 1983

Board of County Commissioners
Hill County
Havre, Montana 59501

Transmitted herewith is the final report for the Hill County High Hazard Location Study. This report documents the results of the traffic studies and surveys performed in the evaluation of five locations in Hill County.

Included in this report are: 1) a thorough assessment of the existing conditions at each site; 2) an accident analysis of all reported accidents at each site during the four-year period from January, 1978 through December, 1981; 3) a short-term, low-cost improvement program complete with a prioritized project list based on the relative hazardousness of each site; and 4) a series of long-term, more expensive solutions, generally involving road reconstruction.

It has been a pleasure working with you, and we appreciate your guidance throughout the project. We hope you are satisfied with this report and find it useful in reducing traffic hazards in Hill County. If you have any questions or are in need of additional information at this time, please don't hesitate to contact us.

Respectfully submitted,

ROBERT PECCIA & ASSOCIATES

Robert J. Peccia, President

Douglas Widmayer, Project Engineer

DW/gp

HILL COUNTY HIGH HAZARD LOCATION STUDY

Prepared For:

Hill County, Montana

In Cooperation With:

State of Montana Department of Justice

Highway Traffic Safety Division

and

the Montana Association of Counties

Prepared By:

Robert Peccia & Associates, Inc.

Helena, Montana

January, 1983

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Note: Due to the nature of Site 3, only the following are included.

- Figure 3A Site Location and Traffic Counts
- Figure 3B Accident Locations and Characteristics

PHOTOGRAPHS

Photo plates are included for each site in their appropriate sections.

CHAPTER I
INTRODUCTION

CHAPTER I

INTRODUCTION

The purpose of this report is to evaluate hazardous road locations in Hill County and to recommend appropriate improvements. The sites were chosen by Hill County with the assistance of the Department of Justice, Highway Traffic Safety Division, based on accident history and roadway characteristics. The sites are referenced in Table 1 below and shown on a location map, Figure I-1.

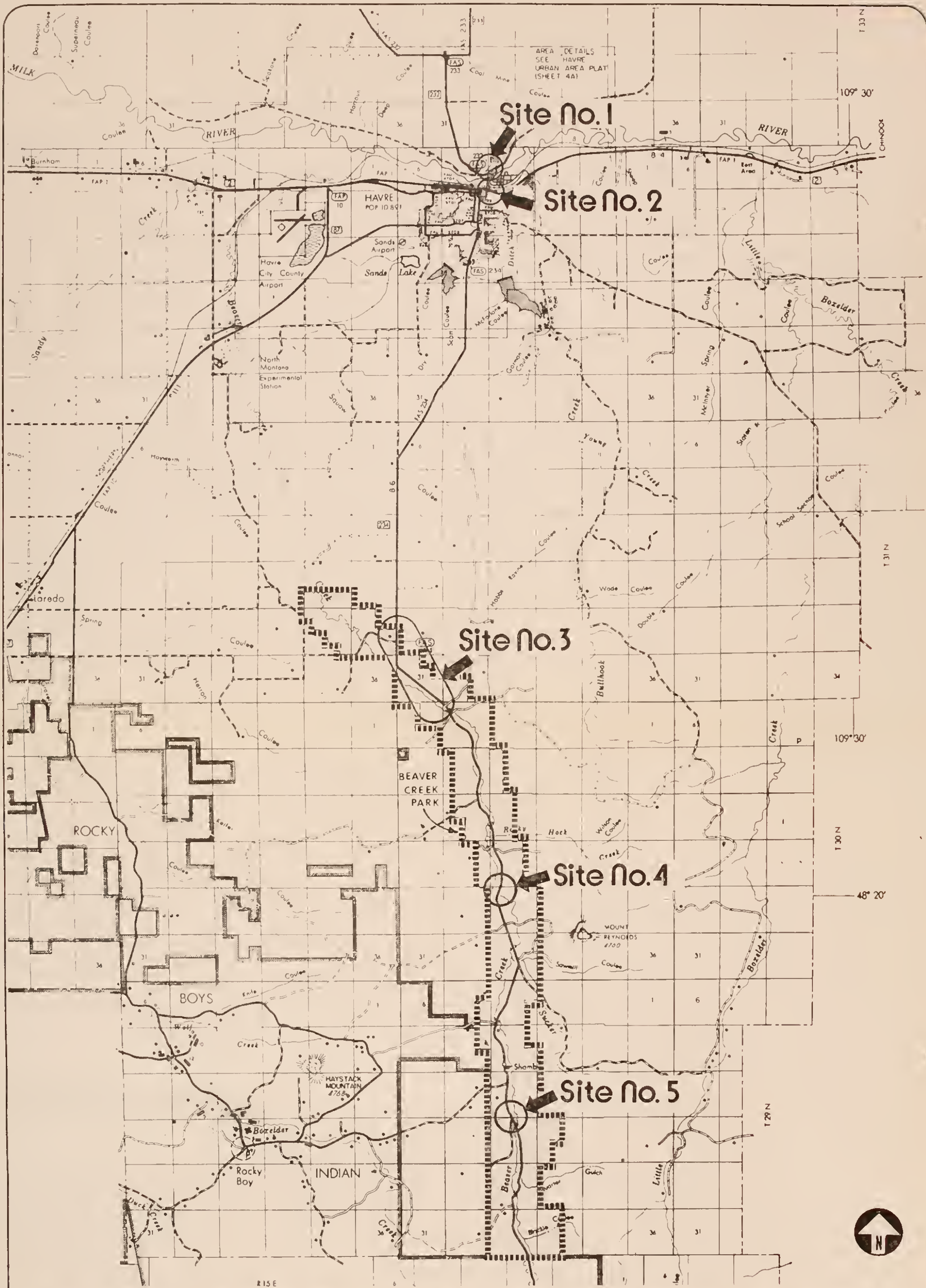
The analysis contained within this report is based on procedures outlined in Report No. FHWA-RD-77-83, Identification of Hazardous Locations, as refined by DCA Project No. 79-04-01-01, Preliminary Evaluation Program for High Hazard Location Study, Yellowstone County, Montana.

Short- and long-term improvements that would reduce or eliminate hazardous conditions have been included for each site. Emphasis was given to relatively low-cost improvements in an effort to present solutions within the funding capabilities of the County. A priority ranking of site improvement projects was developed based on a composite hazard ranking and cost-benefit ratios.

TABLE NO. 1

LIST OF SITES

Site #1:	Intersection of Seventh Avenue North (FAS 232), Sixth Street North and Fifth Street North
Site #2:	Eighth Avenue North
Site #3:	Beaver Creek Road (FAS 234), North Beaver Creek Park
Site #4:	Beaver Creek Road at Rotary Hill
Site #5:	Beaver Creek Road at Mooney Coulee



Hill Co.

Figure No. 1

Hill County High Hazard Site Locations

CHAPTER II
SUMMARY & RECOMMENDATIONS

CHAPTER II

SUMMARY AND RECOMMENDATIONS

A. Summary

The purpose of this study is to identify the factors contributing to unsafe traffic conditions at five hazardous locations selected by Hill County, and to recommend improvements that would remedy the unsafe conditions. At each location, a field inspection was made, the site geometrics were recorded, site condition sketches made, and manual and machine traffic counts taken. In addition, the accident records for the last four years were obtained from the Department of Justice and analyzed.

Solutions to the problems that were identified included short-term low-cost traffic management-type improvements, and long-term more permanent solutions generally involving road reconstruction and higher costs. These recommended improvement costs are summarized in Table 2.

The five hazardous sites selected by Hill County had 46 accidents reported during the four-year period from 1978 through 1981. These accidents included 12 injury and 34 property damage accidents. There were no fatalities reported during the study period. The annual cost of these accidents, according to National Safety Council figures, is $104,000. Based on the average accident reduction figures established by the Department of Highways, the short-term improvements recommended in this report could eliminate 50 percent of these accidents.

B. Short-Term Improvements

The short-term improvements recommended for each site concentrate on supplying better guidance to the motorist through conventional signing and striping methods and on improving sight distance within existing right-of-way limits. In general, the short-term improvements for each site cost less than $1,700. The total cost of all short-term improvements is $5,897.00.

C. Long-Term Improvements

Long-term improvements were recommended where deficiencies at a site could not be completely corrected by short-term, low-cost improvements. The long-term improvements consist of minor road reconstruction (sites 2 and 4), installation of guard rails (sites 4 and 5), and traffic control devices (site 1). Due to the nature and the time frame involved with these long-term improvements, it is recommended that they be implemented as funds become available. The total cost of all the long-term improvements is $26,253, based on 1982 construction costs.

TABLE NO. 2

SHORT- & LONG-TERM IMPROVEMENT COSTS

Site No.	Site Name	Short-Term Improvement Cost	Long-Term Improvement Cost
1.	Intersection of 7th Ave. N (FAS 232), 6th St. N and 5th St. N	$1,580	$ 2,500
2.	8th Ave. N	1,689	10,503
3.	Beaver Creek Road (FAS 234), North Beaver Creek Park	960	*
4.	Beaver Creek Road at Rotary Hill	650	12,170
5.	Beaver Creek Road at Mooney Coulee	1,018	1,080
Total Cost:		$5,897	$26,253

* At Site #3, the optimum long-term improvement discussed in this report was found unsatisfactory by the present Beaver Creek Park Board. It is advised that the Board examine other alternatives that would eliminate the problem of cattle on the road at this site. Due to the Park Board's decision to not allow the optimum solution to be implemented, no long-term improvement cost for this site is presented.

D. Prioritization

To aid the County in deeiding the order of implementation for the short-term improvements, a Priority Ranking has been provided. This ranking evaluates the relative hazardousness of each site and the eost of the short-term improvements.

To evaluate the relative hazardousness of each site, a Hazard Index was ealeulated. This Hazard Index is based on three aeeident indieators (number of aeeidents, aeeident severity, and aeeident rate) and four "non-aeeident" indieators (volume/eapacity ratio, sight distanee ratio, driver expectaney, and information system deficiency). Each site has been ranked aeeording to the aeeident and non-aeeident indieators, and the Hazard Index is shown in Table 3.

To determine the proper order of implementation for the short-term improvements, the eost of the improvement must be evaluated with respeet to the average traffie volume and the site's Hazard Index. Cost factors and benefit/eost ratios were ealculated for each site improvement, and are shown in Table 4.

A Priority Index, whieh is a weighted average of the Hazard Index and the Cost Faetor, was eomputed for each site. The Priority Index ranking is the reeommended order of implementation and should be used as the major consideration in seleeting the order of funding for these sites. Due to possible funding limitations, it may be advantageous to skip one or two improvement projects in order to implement a greater number of improvements. The Priority Index ranking of the short-term improvements is shown in Table 5.

No prioritization has been offered for the long-term improvements due to the costs involved. It is recommended that the long-term improvements be implemented as funds and/or right-of-way beeome available.

E. Implementation

The short-term improvements recommended in this report address the major problems at each site. After evaluating the availability of funds, Hill County should sehedule the implementation of the short-term improvement projeets aeeording to the priority listing shown in Table 5. Due to the relatively low cost of these improvements, it is believed that implementation could be seheduled over a two- to three-year period without beeoming a finaneial burden on the County. It is recommended to complete the short-term improvement program prior to funding any of the long-term improvements.

All long-term improvements are eonsidered of equal importance and should be implemented as funds beeome available.

Throughout this report, when warning signs are recommended, the 30" x 30" size sign is to be used. Likewise, all advisory speed plates should be of the 18" x 18" size. Thé plaeement of all signs, delineators, guard rails, and pavement markings should always be in conformanee with the Manual on Uniform Traffie Control Deviees.

TABLE NO. 3

HAZARD INDEX RANKING

Ranking	Site No.	"Accident" Indicators	Ranking	Site No.	"Non-Accident" Indicators
1	3	42.10	1	2	32.82
2	2	41.04	2	1	27.42
3	5	40.41	3	4	19.66
4	4	32.98	4	3	18.21
5	1	19.65	5	5	17.88

Ranking	Site No.	Hazard Index
1	2	73.86
2	3	60.31
3	5	58.29
4	4	52.64
5	1	47.07

TABLE NO. 4

BENEFIT/COST RANKING

Ranking	Site No.	Short-Term Improvement Cost	Cost Factor Indicator	Benefit/Cost Ratio
1	2	$1,689	98	12.3
2	5	1,018	94	12.1
3	1	1,580	100	8.0
4	4	650	98	2.7
5	3	960	98	1.9

TABLE NO. 5

PRIORITY RANKING OF SHORT-TERM IMPROVEMENTS

Priority Ranking	Site No.	Site Name	Short-Term Improvement Cost	Priority Index
1	2	8th Avenue North	$1,689	79.9
2	3	North Beaver Creek Park	960	69.7
3	5	Mooney Coulee	1,018	67.2
4	4	Rotary Hill	650	64.0
5	1	7th Avenue North, 6th Street North, 5th Street North Intersection	1,580	60.3

CHAPTER III
PROCEDURE & METHODOLOGY

CHAPTER III

PROCEDURE AND METHODOLOGY

A. Field Investigation and Data Collection:

The conclusions and recommendations contained in this report are the product of an extensive data gathering procedure undertaken for each high hazard location. It is impossible to obtain a realistic view of conditions at any particular location without firsthand experience at the site. The background data collected during initial research and on-site visits revealed the circumstances that make one particular location more hazardous than another. The data gathering procedure used during this study included: 1) initial accident research; 2) initial site visit and site identification; 3) site survey; 4) site photography; 5) detailed site sketch; 6) traffic counts; 7) on-site accident analysis; 8) ball bank testing; 9) sight distance determination; 10) subjective rating of site drivability and physical layout; and 11) observation of driver characteristics and quality of travel. The following section contains a brief explanation of each activity undertaken by two field technicians during the data collection stage of this project.

1. Initial Accident Research

The Montana Department of Justice, Highway Traffic Safety Division initially identified accident clusters for individual counties from historical accident reports and accident location plot maps. The accidents within a particular area were then summarized in a list and submitted to Robert Peccia & Associates. All accidents listed were then retrieved and copied from microfilmed records of accident reports. The accident reports were grouped by general location and listed in chronological order. Accidents that occurred during the study period (January, 1978 to December, 1981) were used for further analysis. Those accidents that occurred before or after the study period were retained for reference.

2. Initial Site Visit and Site Identification

The initial visit to each cluster area was made with a representative of each county, if possible, and a representative of the Montana Department of Justice. At this time, the specific high hazard location was identified through the analysis of each group of accident reports and through the input of the local representative. The firsthand knowledge of the long-term accident history and traffic characteristics at each site thus obtained was extremely beneficial.

3. Site Survey

Field technicians utilized survey equipment to identify the physical layout of the roadway itself. Data gathered during the site survey included average road grades within the site, roadway alignment, superelevation in

curves, roadway widths, and identification of approximate right-of-way widths.

4. Site Photography

During site visits, many photographs were taken to illustrate site characteristics or to identify deficiencies within the site. These photographs were utilized in many ways during the preparation of the report and the report graphics. Aerial photography at the largest scale possible was obtained and used during base map preparation and site analysis. In most instances, the combination of aerial photography and extensive "on the ground" photography minimized the need for return visits to the sites.

5. Site Sketch

Sites were stationed at 100-foot intervals and the locations of significant features were mapped. This phase of the data collection involved extensive field measurements of site details including sign locations, pavement marking changes, roadside delineators, utilities adjacent to the roadway, fencing, and roadside vegetation. Site photography was also extensively utilized to produce accurate sketches.

6. Traffic Counts

Available traffic count data was obtained from the Planning and Research Bureau of the Montana Department of Highways and used for as many sites as possible. For those sites lacking such information, 24-hour recording traffic counters set to record traffic volumes in 15-minute intervals were set at the required locations. If the site included a major intersection and traffic was significant, peak hour turning movements were conducted in addition to 24-hour traffic counts. This traffic data was used to determine the average daily traffic (ADT) and for capacity analysis. Traffic counts conducted by Robert Peccia & Associates were submitted to the Department of Highways to augment their traffic count data.

7. Accident Analysis

All reported accidents for each specific site location that occurred during the study period of 1/78 through 12/81 were plotted on collision diagrams. Accident data for the study period was also summarized and used in the field. These summaries allowed the field technicians to reconstruct the accidents and to better understand the circumstances that made for unsafe driving conditions at a particular site. The number of accidents and traffic volumes were used to compare accident rates of specific sites.

It should be noted that alcohol-related accidents have been categorized in two ways on the accident data summary sheet contained in each site analysis. Alcohol involvement in the accident was listed to reflect the possible violation of the drivers involved in the accident (i.e., driving while intoxicated). In this item, alcohol was treated in the same manner as reckless driving, speeding, and other driving violations. In addition, an accident tally was completed that summarized the number of times drinking was listed as a possible violation and identified the number of accidents that had some form of alcohol involvement by the driver or passengers.

8. Ball Bank Testing

The vehicle utilized during field data collection was equipped with a ball bank indicator or safe curve speed indicator. The instrument provides a simple way to establish the safe advisable speed necessary to comfortably pass through a curve. All posted advisory speeds on curves were verified through the use of this instrument.

9. Stopping Sight Distance Determination

Sight distance is a major element in the safe and efficient operation of any roadway. Stopping sight distance, the minimum distance needed for a vehicle traveling near or at the design speed for the roadway to stop for an object in its path, was measured by two field technicians. Actual sight distance limitations were measured using an eye height of 3.75 feet and an object height of 0.5 feet. Vehicle speed, roadway surface conditions, obstructions, and driver characteristics were also considered in sight distance measurement. The measurement of sight distance at intersections required the development of a minimum sight triangle, which considers unobstructed sight distance along both roads at an intersection and across the included corner.

10. Subjective Rating of Site Drivability and Physical Layout

After the field data was gathered for each site, two field technicians independently rated the drivability of the site and the completeness of the information system presented to motorists entering the site. The rating was completed on the Driver Expectancy and Information System Deficiencies forms, which are discussed in the following section of this chapter. These ratings present a relatively unbiased impression of the site layout and characteristics, since they were arrived at independently by technicians who were not familiar with the site prior to the data collection phase of the project.

11. Observation of Driver Characteristics and Quality of Travel

During the collection of field data, time was taken to observe motorists' driving habits through each site. Field observations of drivers were completed both during day and nighttime light conditions to obtain an overall impression of driver tendencies and to detect deficiencies in the overall layout of the site.

B. Analysis of Data and Calculation of Hazard Indices:

A hazard index was calculated for each site based on the following seven indicator values:

1. Number of Accidents
2. Accident Rate
3. Accident Severity
4. Volume/Capacity Ratio
5. Sight Distance
6. Driver Expectancy
7. Information System Deficiencies

For each indicator, a value between 0 and 100 was calculated, with 0 representing no hazard and 100 representing the most hazardous. The indicator values were then weighted and totalled according to accepted Department of Justice methods and values outlined in DCA Project No. 79-04-01-01 to yield the Hazard Index.

The improvement costs for each site were calculated using current construction costs and weighted against the accident reduction benefits associated with the type of improvement. In addition to the cost/benefit ratio, a cost factor was determined. The cost factor represents the improvement costs per vehicle computed by dividing the total cost for improvements at a site by the number of vehicles entering that location over a period of five years. A five-year period is used because that is the average service life of the recommended short-term improvements. The form used to compute the cost factor is shown in Figure A2 in the Appendix.

The final phase in the analysis was to determine the Priority Index (P.I.). The Priority Index is the weighted average of the Hazard Index (H.I.) and the Cost Factor (C.F.), as shown in the following equation:

$$P.I. = 0.75\ (H.I.) + 0.25\ (C.F.)$$

The site improvements were then ranked according to priority based on the Accident Hazard Indicators, Non-Accident Hazard Indicators, Benefit/Cost Ratios, Hazard Index, and Priority Index.

The following section contains a brief explanation of each of the Hazard Indicators and the Benefit/Cost Ratio.

1. Number of Accidents:

Accident records for a four-year period from January, 1978 through December, 1981 were obtained from the Montana Highway Patrol. This accident data was then used to determine the three "accident" indicators (number of accidents, accident rate and accident severity). The annual average number of accidents occurring at each site was used to calculate this indicator value. Figure A3 in the Appendix shows the relationship between the annual number of accidents and the indicator value.

2. Accident Rate:

This indicator is used to compensate for the wide range of traffic volumes found throughout the study sites. The average daily traffic entering each site was calculated and adjusted to represent a four-year volume. The total number of accidents per million vehicles entering the site was then calculated, resulting in the accident rate. This figure was entered into Figure A4 in the Appendix to yield the corresponding indicator value.

3. Accident Severity:

This indicator evaluates the severity of the accidents occurring at each site in terms of dollars. A "Relative Severity Index" (Table A1 of the Appendix) was used to rate each accident according to accident type and to assign a corresponding accident cost. The R.S.I. values used are those in-

cluded in DCA Project No. 79-04-01-01. The average of the R.S.I. values at each site was calculated and entered into Figure A5 in the Appendix to determine the appropriate indicator value.

4. Volume-to-Capacity Ratio:

The individual characteristics of the sites vary greatly. This indicator value normalizes each site with respect to lane width, geometrics, traffic mix and volume. The capacity of each site was calculated for Service Level C in accordance with the Highway Research Board, Special Report 87, Highway Capacity Manual. The volume used represents the average daily traffic entering the site. The equation used to compute the index is as follows:

$$\frac{V}{C} = \frac{ADT}{24\ (Capacity)}$$

This ratio was entered into Figure A6 (found in the Appendix) to yield the corresponding indicator value.

5. Sight Distance:

The sight distance at a particular site is an excellent indicator of the hazardousness of that location. Critical sight distances were measured at each location based on the criteria outlined in the DCA Project No. 79-04-01-01. The desirable sight distances for each particular location were then calculated according to the AASHO Manual Geometric Design of Rural Highways. For each case, the ratio of the existing versus the desirable Sight Distance was calculated. The two worst cases at each site were evaluated and a weighted average was computed by assigning a weight of two to the worst rating and one to the other rating. This weighted average sight distance ratio entered into Figure A7 (found in the Appendix) yields the corresponding indicator value.

6. Driver Expectancy:

The driver expectancy indicator is a purely subjective method of evaluating the ability of the average motorist to negotiate a particular section of roadway or intersection. Each site approach was rated using the criteria included on the driver expectancy form shown on Figure A8 in the Appendix. Each site was evaluated individually by two technicians and the ratings were averaged. The two approaches with the worst ratings were used in the calculation of the indicator value. A weighted average of the two ratings was calculated according to DCA weighting methods and used in Figure A9 of the Appendix to compute the corresponding indicator value.

7. Information System Deficiencies:

Similar to the driver expectancy ratings, this indicator is based on the subjective judgment of the evaluator. This rating consists of evaluating the signing and striping systems at each site with respect to the systems' ability to inform and guide the motorist through a particular section of road or in-

tersection. The actual criteria used in this evaluation are shown on the rating form (Figure A10) found in the Appendix.

All site approaches were independently rated by two technicians and their ratings averaged. Only the two worst average approach ratings were actually used to calculate this indicator. A weighted average of the two ratings was computed according to the weighting formula outlined in DCA Project 79-04-01-01. This weighted average was entered into Figure A11 in the Appendix to yield the appropriate indicator value.

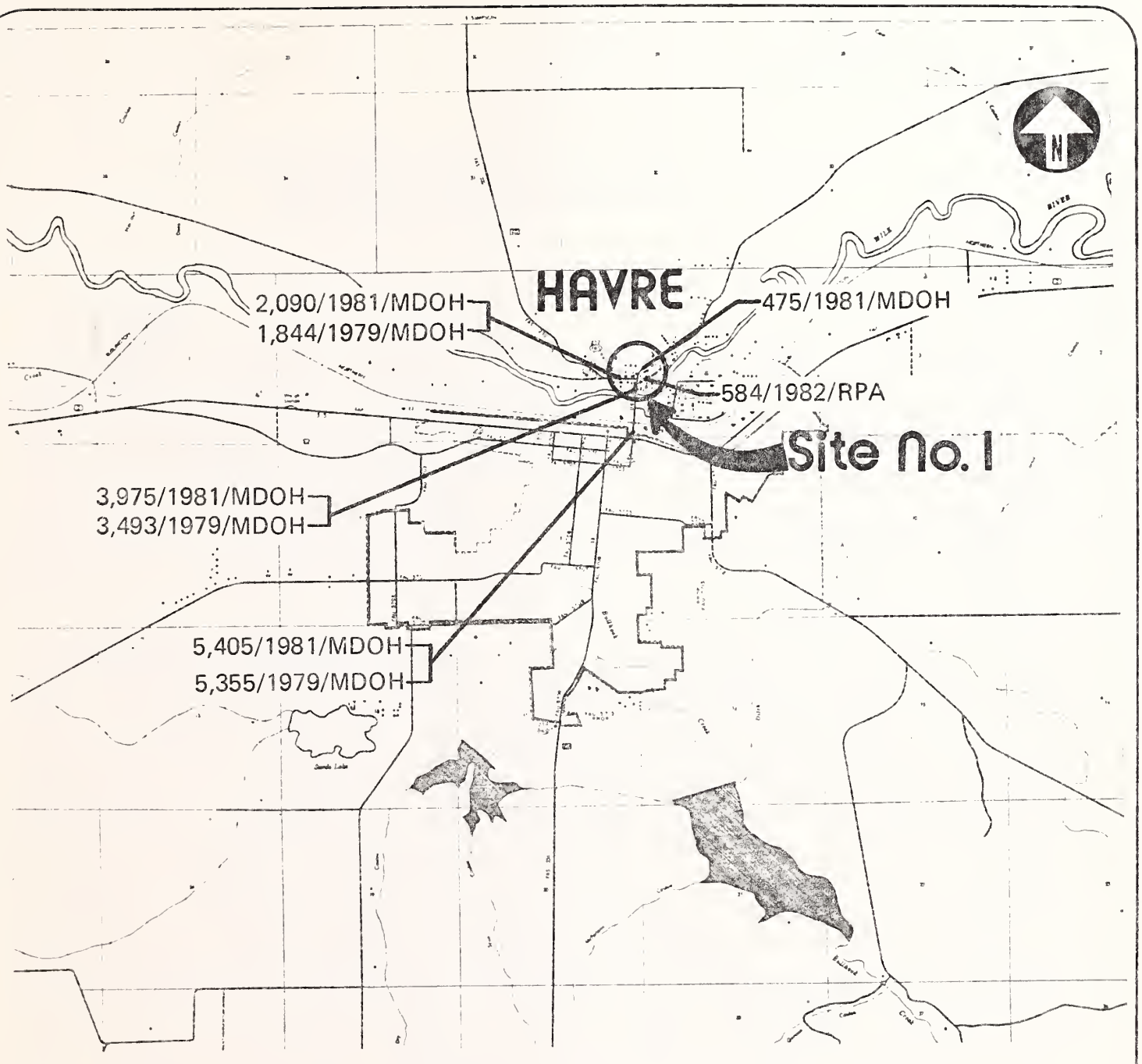
8. Benefit/Cost Ratio:

Each site was analyzed and improvements were recommended. The improvement costs were estimated based on current Department of Highways statewide average construction costs. Although it is likely that Hill County will implement some of the improvements with County forces, the "contracted" construction costs were used throughout for comparison purposes.

The benefits of each improvement were calculated based on the anticipated accident reduction resulting from that particular improvement. The Montana Department of Highways method for calculating the benefit/cost ratio was used and the computation format is shown in Figure A12 of the Appendix. A ranking of each site based on the benefit/cost ratio was compiled and is presented in Table 4. The site improvement yielding the greatest accident reduction benefit per dollar spent was given the highest ranking.

CHAPTER IV
SITE ANALYSIS

site no. 1



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
7th AVE. NORTH

Figure No.
I-A
Hill Co.

SITE #1

Intersection of 7th Avenue North (FAS 232), 6th Street North and 5th Street North

A. Location

Site #1 is located in north Havre approximately one-half mile north of US 2 (FAP 1). The site includes the intersection of 7th Avenue North (FAS 232), 6th Street North and 5th Street North. The site is situated in primarily a residential area; however, commercial and industrial uses also exist in the area. Seventh Avenue North (FAS 232) serves as an important farm-to-market road in Hill County and is used as a major route for traffic to and from Canada. The location of Site #1 and the available traffic count data for the site is presented in Figure 1A.

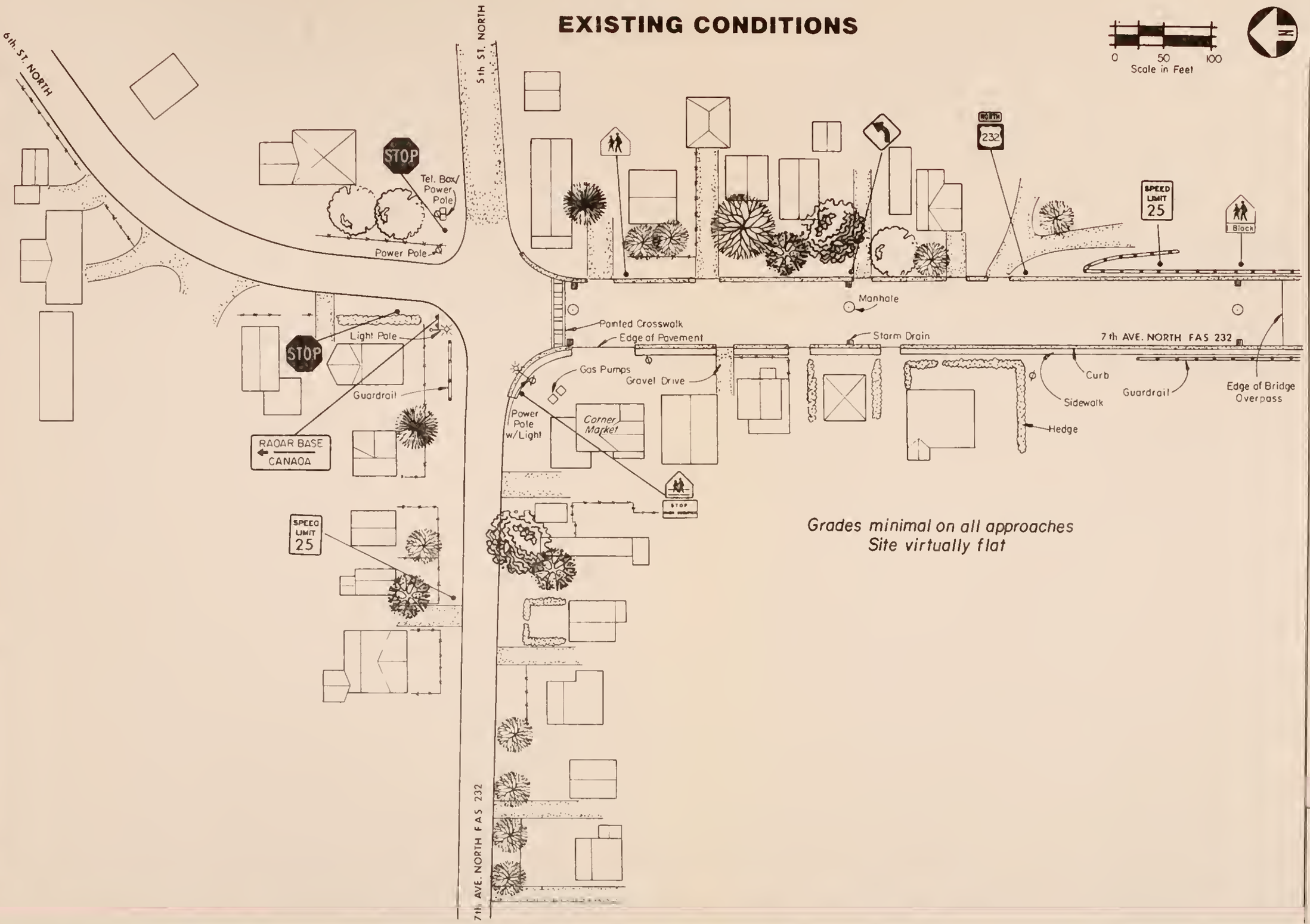
B. Existing Conditions

All legs of the intersection, with the exception of 5th Street North, have asphalt pavements. Seventh Avenue North varies in width from 44 feet on the south leg where curb and gutter exists, to 24 feet on the west leg of the intersection. The grades on both the south and west approaches to the intersection are virtually flat. Both approaches have been striped; however, the pavement markings were quite worn and difficult to see at the time of the site inspection. The posted speed limit for 7th Avenue North is 25 mph. A painted crosswalk is located just south of the intersection on 7th Avenue North which is used heavily by local residents patronizing a corner grocery store and by school children travelling to and from the school bus stop on the east side of the intersection. Signing on the south leg of the intersection includes "Pedestrian Crossing - 1 Block", "Speed Limit 25", a curve warning sign, and a "Pedestrian Crossing" sign at the crosswalk. Signing on the west approach includes a "Pedestrian Crossing - 1 Block" sign located approximately 650 feet from the intersection and a "Pedestrian Crossing - Stop When Occupied" sign approximately 220 feet from the intersection.

The north approach to the intersection (6th Street North) has an asphalt surface that varies slightly in width but is typically 24 feet wide. The north leg of the intersection curves sharply approximately 150 feet north of the intersection, and the surrounding vegetation severely limits sight distance in the area. A stop sign is located approximately 30 feet from the intersection. This stopping location is not adequate for viewing the intersection, and drivers tend to "nose out" to obtain a better view of oncoming traffic. A hedge growing about 15 feet from the roadway is responsible for the sight distance obstruction; however, the hedge has been trimmed to reduce the hazard.

Fifth Street North comprises the east leg of the intersection and is a 40-foot-wide gravel-surfaced roadway. Signing on this leg is limited to a

EXISTING CONDITIONS



Grades minimal on all approaches
Site virtually flat

INTERSECTION OF 7th AVE. NORTH, 6th STREET NORTH & 5th STREET NORTH

Site No.

Figure No.
I-B

Hill Co.

Existing Site Conditions

Intersection as viewed from north approach. Sight distance limitation caused by hedge at northwest corner of intersection.

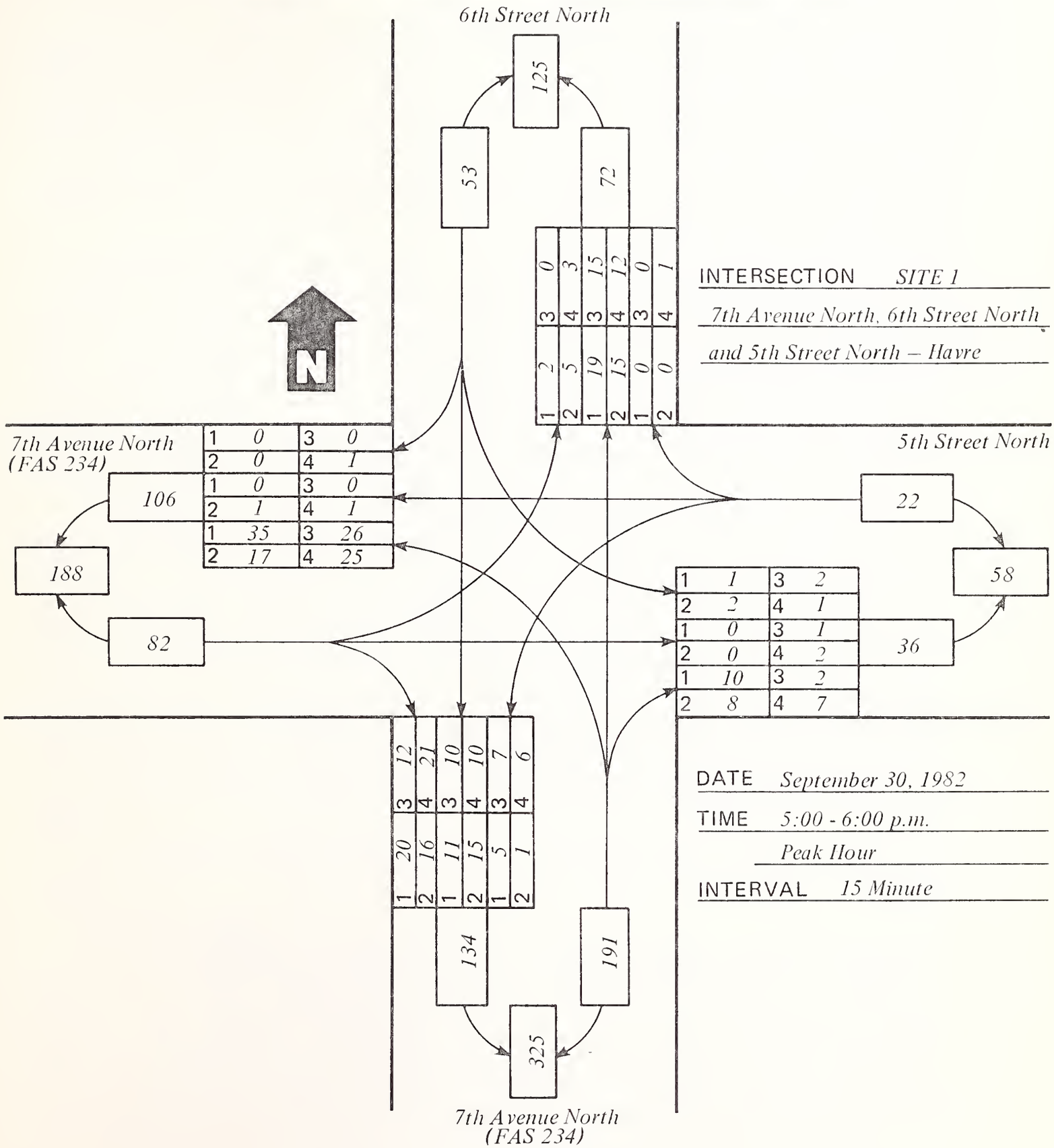
View of north approach to the intersection.

View of intersection from south approach. Note trees obstructing view of sign on east side of roadway.

View of west approach to the intersection. Note the lack of visible pavement markings.

Plate 1

TURNING MOVEMENTS



INTERSECTION *SITE 1*

7th Avenue North, 6th Street North and 5th Street North – Havre

DATE *September 30, 1982*

TIME *5:00 - 6:00 p.m.*

Peak Hour

INTERVAL *15 Minute*

Robert Peccia & Associates

stop sign located at the intersection. No speed limit signs were posted; however, the condition of the roadway limits speeds.

ADT for the site was determined from an analysis of 24-hour machine traffic counts conducted by the Montana Department of Highways and Robert Peccia & Associates. In addition, peak hour turning movements were conducted for the intersection by Robert Peccia & Associates. Traffic was determined to be 3,975 vehicles per day on the south leg and 2,090 vehicles per day on the west leg of the intersection.

The existing conditions at this site are depicted in the site sketch (Figure 1B) and in photographs of the site (Plate 1).

C. Accident History

A total of six single-vehicle accidents were reported at this location during the four-year study period. Two of the six accidents resulted in injuries to a total of three persons. All accidents reported at this site were fixed object accidents and three occurred as vehicles were attempting to execute the left turn necessary to continue travel on FAS 232. Five of the six accidents occurred at night, even though the intersection is lighted. In addition to darkness, major contributing factors to accidents at this location are snowy or icy road conditions and excess speed. Alcohol was involved in three of the six reported accidents at this site.

Based on a review of the accidents at this location, it appears that the major problems for drivers are experienced as they attempt to make a left turn and continue travel on FAS 232. Due to the four-way traffic at this intersection, it is impractical to design roadway geometrics to improve the approach from the south without hindering other traffic movements. As a result, excess speed coupled with slippery road conditions tend to force drivers to the outside during the left turn movement. Problems have also been experienced by drivers on the north approach to the intersection. The north approach to the intersection is a long straight section of roadway with a rather sharp curve just north of the intersection. A review of accidents on this north leg indicates that drivers have difficulty identifying and negotiating the curve. The composite collision diagram for this site is depicted in Figure 1C.

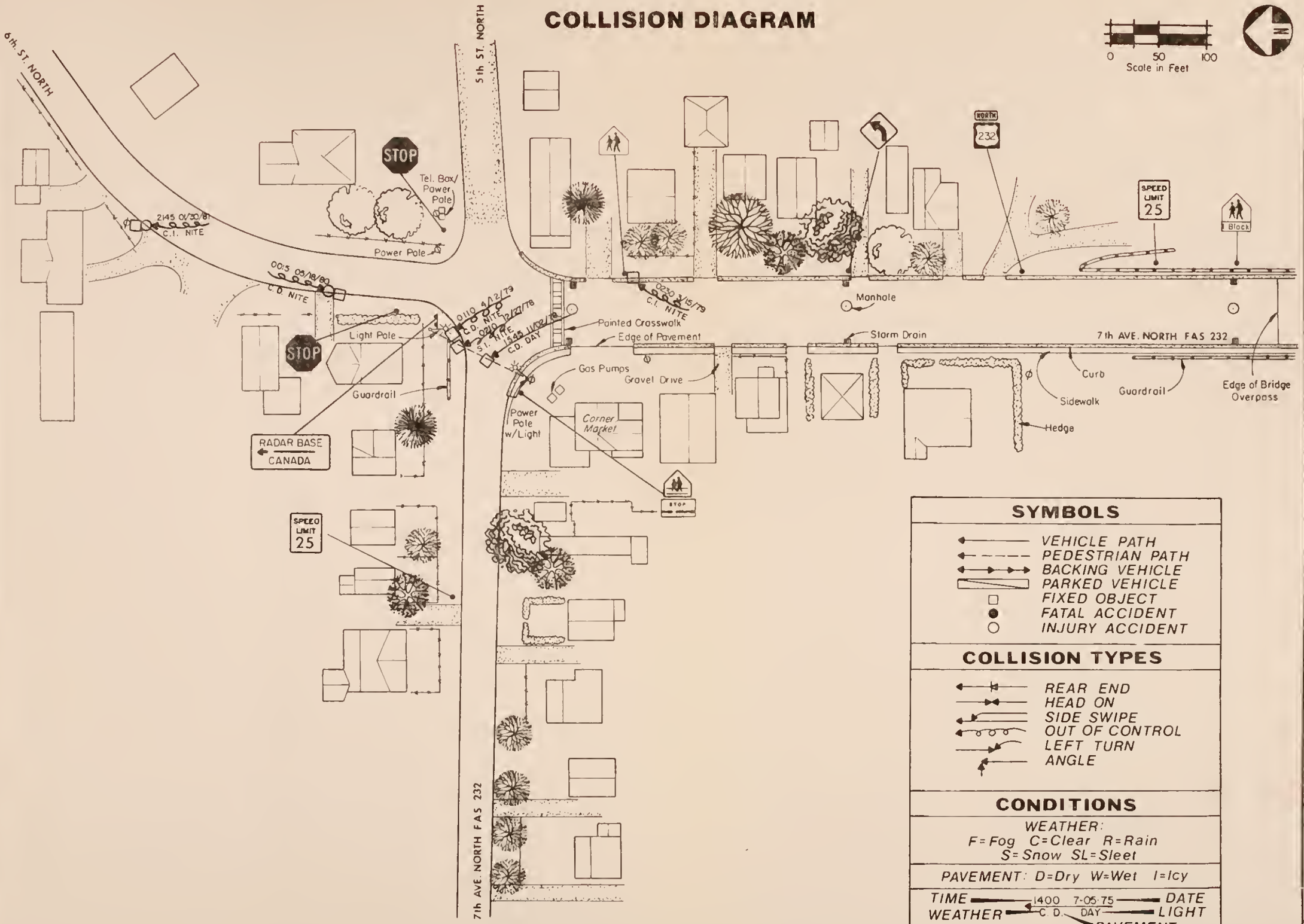
The accident rate for this site is 1.2 accidents per million vehicles entering (MVE).

D. Recommendations

This intersection is complicated by the large turning movement between the south and west approaches created by the through traffic on FAS 232. Based on field observations and available accident data, it appears that the motorist has difficulty identifying the intersection and therefore vehicle speeds are often too fast for the curve. The north approach to the intersection is inadequately signed and does not provide enough advance notice of the approaching configuration. It is important to effectively identify this intersection and give the motorist enough advance warning.

As a long-term improvement, it is recommended that a red/amber flashing beacon be installed at this intersection. In this particular case the beacon will provide the most effective means of identifying the intersection, especially at night.

COLLISION DIAGRAM



SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C D DAY LIGHT
PAVEMENT

INTERSECTION OF 7th AVE. NORTH, 6th STREET NORTH & 5th STREET NORTH

Site No.

Figure No. 1-C

Hill Co.

ACCIDENT DATA

Intersection of 7th Avenue North (FAS 232), 6th Street North, and 5th Street North

SITE NUMBER 1 ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
2	2	1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2			1	2	1	

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		1	1	1						1	1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2	2													1							1		

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
1	5		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
3			3	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
5		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			6						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
2	3	1						

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury			1	1
Fatality				
Property Dam. Only	2	2		

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

3

The short-term improvements recommended for this site consist of signing and pavement marking as follows:

1. The curve situation at this intersection should be identified through the use of warning signs. It is recommended that a curve warning sign (W1-1R) and a 10 mph advisory speed plate (W13-1) be installed 500 feet back from the intersection on the west approach. By using a ball bank indicator, it was determined that the maximum safe speed for this curve is 10 mph.

2. To better identify the curve from the south approach, the existing curve warning sign (W1-2L) should be removed and replaced with an oversized (36" x 36") turn warning sign (W1-1L) with a 10 mph advisory speed plate 24" by 24" in size (W13-1). Although the location of the curve warning sign is not optimum, the oversized sign at this location will catch the attention of motorists and still allow enough time to react.

3. To increase the effectiveness of the existing signing, the trees along the east side of the south approach should be pruned back. This type of roadside pruning should be included in the annual maintenance schedule. At the time of this study, the existing curve warning sign was rendered ineffective by the overhanging tree limbs.

4. The north approach consists of a sharp curve to the left that is not delineated and is poorly lighted. A pair of turn warning signs (W1-1) and 15 mph advisory speed plates (W13-1) should be installed on this approach. According to the ball bank indicator tests done, the appropriate and safe speed for this curve is 15 mph. The warning sign for northbound traffic should be located approximately 50 feet north of the intersection. The sign for the southbound traffic should be installed 750 feet back from the beginning of the curve.

5. To better delineate the curve on the north approach, a series of reflectorized delineators (Design C, 4" x 4") should be installed. The reflectors should be located so that the motorist is led through the curve. It is anticipated that a total of ten reflectors will be required to effectively delineate this approach.

6. The stop sign (R1-1) on the north approach should be relocated approximately 30 feet closer to the intersection. This will allow the stopped motorist to see much more of the west approach. The hedge on the northwest corner should be pruned to allow greater sight distance.

7. The existing school advance sign (S1-1) located on the southeast corner of the intersection is not appropriate. The existing sign should be removed and replaced with the more appropriate school crossing sign (S2-1) and the supplemental "Stop When Occupied" sign (S2-1S). This change will make the signing of the pedestrian crossing conform to State signing standards.

8. Although there was evidence of some pavement marking at this site, the existing markings were ineffective due to their poor condition. It is recommended that maintenance of the pavement markings be upgraded. The intersection and its paved approaches should be restriped several times a year, if necessary. In addition, pavement markings are often obscured by a build-up of sand from the snow and ice maintenance program. Brooming the intersection periodically will improve the visibility of the existing markings.

Besides the existing centerline and shoulder stripes, a stop bar should be installed adjacent to the stop sign on the north approach. A dashed six-inch-wide yellow stripe should be installed around the curve in the intersection to identify the curve and better channelize the traffic.

9. To minimize confusion at this location, the use of a route marker has been employed on the south approach, and it is recommended that this practice be expanded. A directional arrow (M5-1) should be added to the existing route marker on the south approach. A new route marker (M1-4), cardinal direction marker "North" (M3-1) and a directional arrow (M6-1) should be installed on a single post in the direct line of the south approach located behind the existing guard rail. The route markers are essential to guide the motorist through the intersection in a simple, direct manner and to reduce confusion and indecision.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
3	ea	Install Turn Warning Sign (W1-1)	$130	$390
3	ea	Install Advisory Speed Plate (W13-1)	$50	150
1	ea	Remove Existing Curve Warning Sign (W1-2)	$30	30
1	ea	Install Oversized (36" x 36") Turn Warning Sign (W1-1)	$60	60
1	ea	Install Oversized (24" x 24") Advisory Speed Plate (W13-1)	$60	60
-	Lump Sum	Prune Tree Limbs on South Approach and Hedge on Northwest Corner	$300	300

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
10	ea	Install Reflectorized Delineators (Type "C", 4" x 4" silver)	$18	$180
1	ea	Relocate Stop Sign (R1-1)	$60	60
1	ea	Remove School Advance Sign (S1-1)	$35	35
1	ea	Install School Crossing Sign (S2-1)	$60	60
1	ea	Install School Crossing Supplemental Sign (S2-1S) "Stop When Occupied"	$50	50
1	ea	Install Painted Stop Bar (white)	$20	20
150	lf	Install Yellow Dashed Paint Striping Around Curve in Intersection	$.10/lf	15
1	ea	Install Route Marker (30" x 24") (M1-4)	$60	60
1	ea	Install Cardinal Direction Marker (24" x 12") (M3-1)	$30	30
2	ea	Install Directional Arrows (21" x 15") (M5-1 & M6-1)	$40	80

TOTAL COST: $1,580

BENEFIT/COST RATIO: 8.0

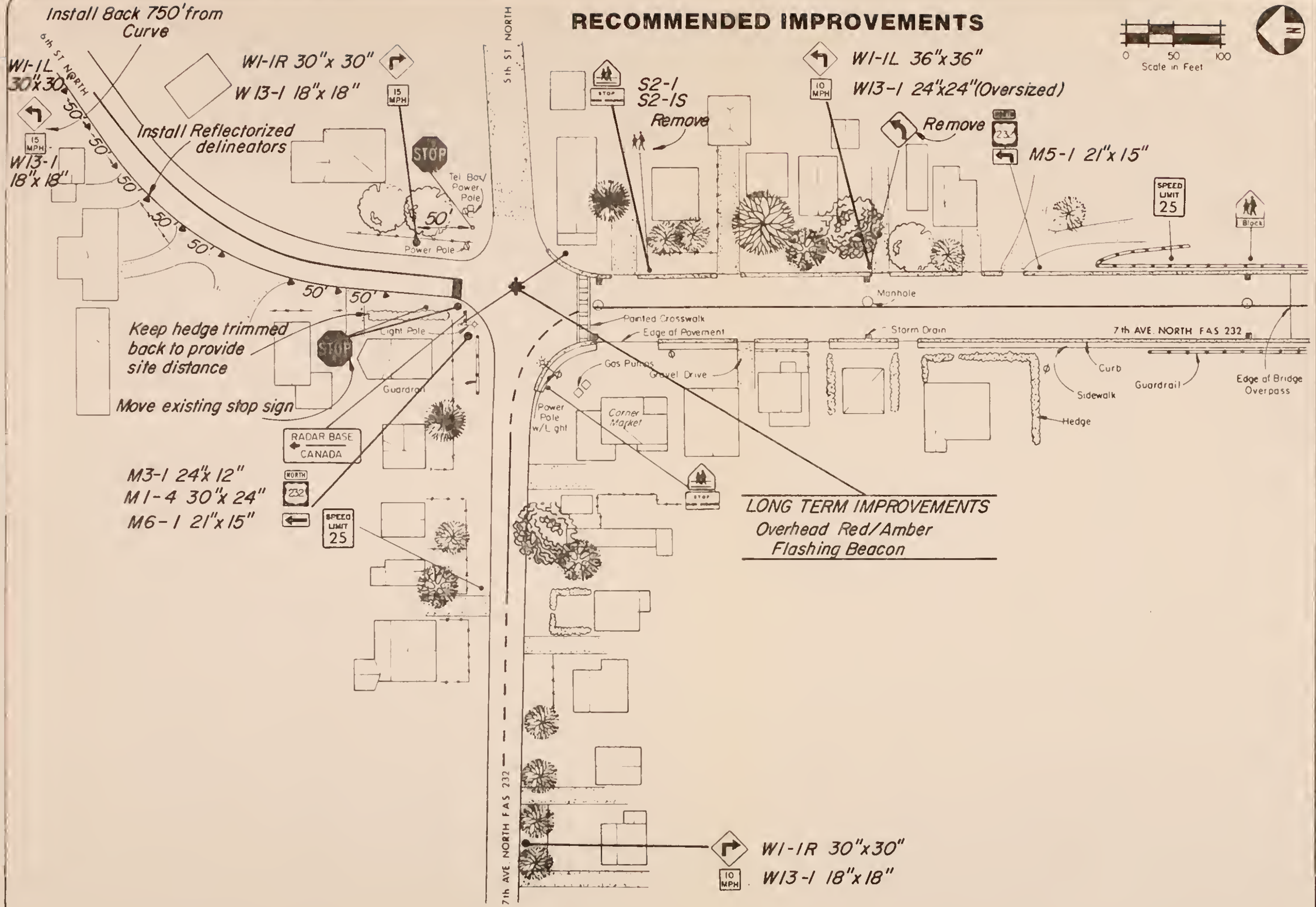
Long-Term Improvements

In this particular situation, the most effective way to identify this intersection is to install a red/amber flashing beacon. Flashing beacons are generally used at locations where full traffic control signals are not warranted but where, because of lack of sight distance or other hazard, signs alone are not sufficient. This long-term improvement should be implemented when traffic volumes and/or accident rates at this location warrant the additional traffic control.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	Lump Sum	Install an Overhead Red/ Amber Flashing Beacon (Including 30 amp Service and Control Assembly)	Lump Sum	$2,500

RECOMMENDED IMPROVEMENTS



INTERSECTION OF 7th AVE. NORTH, 6th STREET NORTH & 5th STREET NORTH

Site No.

Figure No. I-D

Hill Co.

DETERMINATION OF HAZARD INDEX

Site Number *1* Date *December, 1982*

Site Description *Intersection of 7th Avenue North, 6th Street North and 5th Street North*

Indicator	Data Value		Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.5*	acc/yr	*33*	x 0.164 =	*5.41*
Accident Rate	*1.2*	acc/MVE	*20*	x 0.225 =	*4.50*
Accident Severity	*5,900*	dollars	*51*	x 0.191 =	*9.74*
Volume/Capacity Ratio	*0.16*		*34*	x 0.082 =	*2.79*
Sight Distance Ratio	*0.86*	(wt. avg.)	*47*	x 0.074 =	*3.48*
Driver Expectancy	*4.5*	(wt. avg.)	*75*	x 0.149 =	*11.18*
Information System Deficiencies	*5.2*	(wt. avg.)	*86.7*	x 0.115 =	*9.97*

Hazard Index: *47.07*

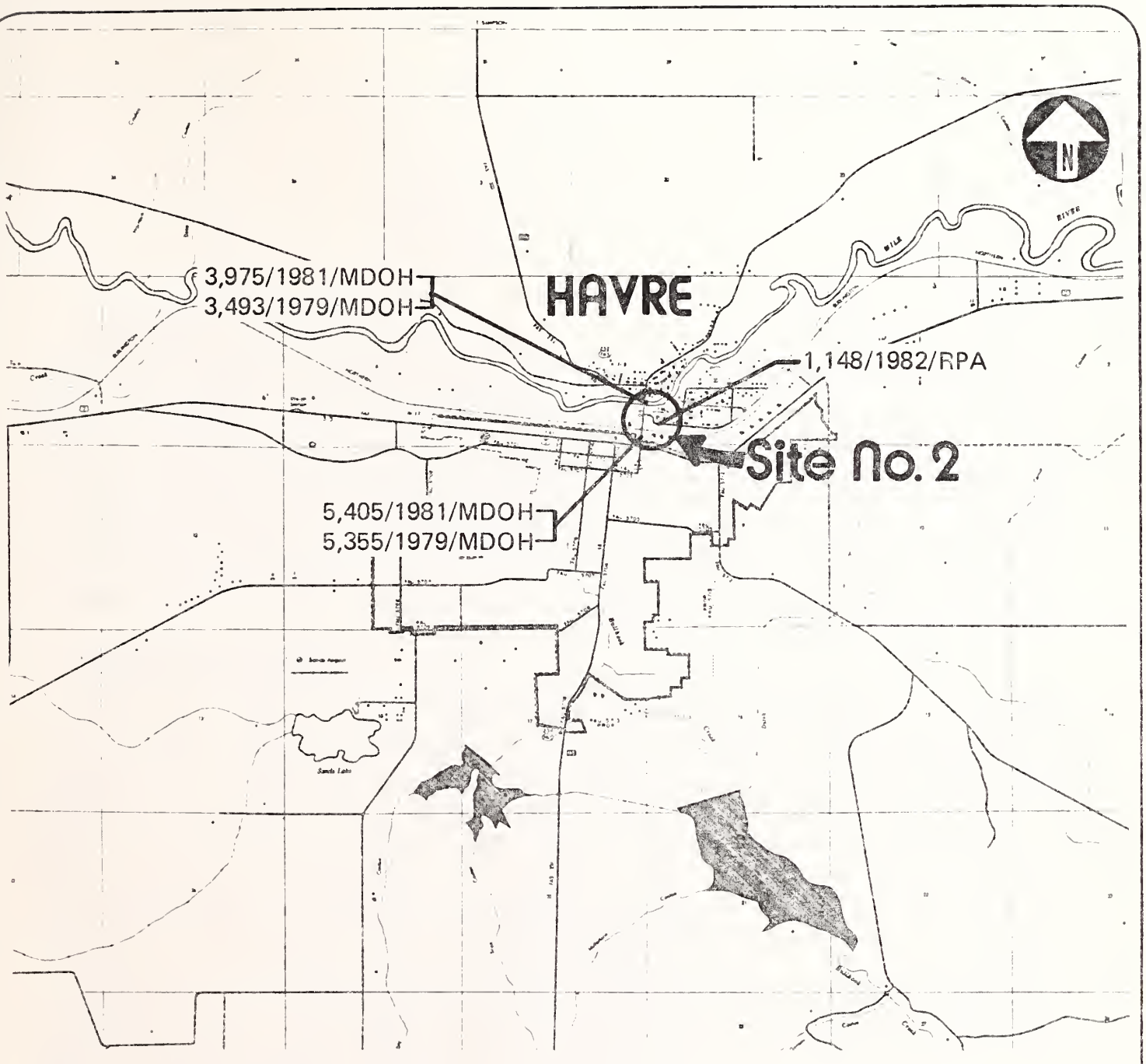
Cost of Recommended Improvements: *$1,580*

Cost Factor: *100*

Priority Index = Hazard Index x .75 + Cost Factor x .25

47.07 x .75 + *100* x .25 = *60.3*

Site No. 2



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
8th AVE. NORTH

Figure No.
2-A
Hill Co.

SITE #2

Eighth Avenue North

A. Location

Site #2 is located approximately one-quarter mile north of U.S. 2 (FAP 1) in North Havre. The site begins at the intersection of 8th Avenue North with 7th Avenue North (FAS 232), midway between the north end of the railroad viaduct and the south end of the Milk River Bridge. Eighth Avenue North then continues eastward and southward through the intersection with 1st Street North (Rail Street). The site is located in primarily a residential area of North Havre. A large furniture store and warehouse are also located in the area and receive a fair amount of traffic during business hours. The location of Site #2 and existing traffic count data is presented in Figure 2A.

B. Existing Conditions

Eighth Avenue North has an asphalt pavement surface that is typically 26 feet wide. Grades range from 4 percent from the intersection with 7th Avenue North to the intersection with 2nd Street North, to approximately .75 percent at the intersection of 8th Avenue North and 1st Street North. Non-reflectorized guard rail is located along the north shoulder (river side) of the roadway and on the outside of the curve. Roadway alignment changes 90 degrees two times through the curves at this site. Field surveys indicate that the superelevation changes from sloping at 1 percent to the outside as vehicles enter the broad curve, to flat midway through the curve, and finally to a slope of .4 percent to the inside as the curve ends. The superelevation on the corner at the intersection of 8th Avenue North and 1st Street North is approximately 2.3 percent to the inside of the curve. Field observations indicate that eastbound vehicles tend to be thrust out slightly in the curve, but westbound vehicles experience few problems.

There were no pavement markings through the site at the time of the field investigation; however, the site is known to have been striped in the past. Signing at the site presently consists of two stop signs, one of which is located at the intersection of 8th and 7th, and the other is located on the relatively lightly used westerly extension of 1st Street North. In addition, a regulatory speed limit sign for 15 mph is posted approximately 125 feet from the corner on First Street North. The existing signing appears to be of little benefit to eastbound drivers. Obstructions are generally located more than six feet from the roadway surface; however, a power pole is located only two feet from the edge of the roadway on the inside of the corner at the intersection of 8th and 1st. A large metal building located near the same intersection limits sight distance to approximately 125 feet. Existing conditions at this site are depicted in the accompanying sketches and photographs.

Based on 24-hour machine traffic counts conducted by the Montana Department of Highways and Robert Peccia & Associates, the average daily

EXISTING CONDITIONS

0 50 100
Scale in Feet

N

MILK RIVER

MILK RIVER FLOOD PROTECTION PROJECT CORPS OF ENGINEERS U.S. ARMY

welcom e to NORTH HAVRE Little Community ~ Big Heart

STOP

Guardrail

Gravel Pull-off

Metal Gate

Top of Dike

4%

Top of Bank

Toe of Bank

-1.0% Superelevation

0.4% Superelevation

4%

Guardrail

Curb

Power Pole

Concrete Curb Parking Blocks

Furniture Store

Parking Area

Toe of Bank

STOP

2nd ST. NORTH

8th AVE. NORTH

.75%

Christian Armory Bldg

SPEED LIMIT 15

Wire Fence w/ Wooden Posts

End of Overpass Bridge

Curb

Guardrail

Furniture Store Sign Post

2.3% Superelevation

Street Sign Post

Power Pole

Curb

Lightpole

Guardrail

Sidewalk

7th AVE. NORTH FAS 232

.75%

.75%

1st. ST. NORTH

STOP

Wire Fence w/ Metal Posts

Site No. 2

8th AVENUE NORTH

Figure No.

2-B

Hill Co.

Existing Site Conditions

Corner of Eighth Avenue North and First Street North. Note close proximity of power pole and street sign to edge of the roadway.

View of First Street North (Rail Street). Note long tangent section leading into the sharp corner.

Looking southward through the site. Note the sight distance limitation caused by the Christian Armory Building. Sight distance limited to less than 150 feet at this point.

Looking northward through the site. Note grades and the lack of shoulder on the inside of the curve.

Plate 2

traffic (ADT) was determined. The ADT for 7th Avenue North at the Milk River Bridge was 3,975 vehicles per day and the ADT for 8th Avenue North - 1st Street North was 1,148 vehicles per day. In addition to the machine counts of traffic at this site, peak hour turning movement counts were also completed. The peak houring turning movement summary is contained in the site analysis.

C. Accident History

During the four-year study period, nineteen accidents were reported at this location in North Havre. Four people were injured in the three injury accidents during the study period. The majority of the accidents occurred during the day under clear weather conditions. Eleven of the nineteen reported accidents occurred during icy road conditions. Only six accidents during the period involved single vehicles. The majority of the collisions were angle, rear end or sideswipe accidents. The accidents occurred in three primary areas within the site: 1) the intersection of 7th and 8th; 2) the curve through the site; and 3) the intersection of 8th and 1st.

Most of the accidents at the site involved fixed objects, sideswipes, or head-on collisions. These accidents appear to involve motorists executing right turns while descending from the railroad viaduct onto 8th Street North. This 180-degree turn is very tight, and the situation is further compounded by an inconsistent superelevation through the turn and icy or snowy road conditions. Angle accidents have generally occurred at the corner of 8th and 1st Streets North. Over the four-year study period, eight angle collisions and one fixed object accident have been reported, all of which occurred during daylight hours and under snowy or icy road conditions. These circumstances indicate that the accidents are most likely the result of a lack of sight distance caused by the location of the Christian Armory Building, a lack of adequate traffic control at the corner, and icy or snowy road conditions. The corner is not lighted; however, it appears that the lack of nighttime accidents at the corner may be the result of the motorists' ability to see the headlights of approaching vehicles and exercise caution entering the intersection.

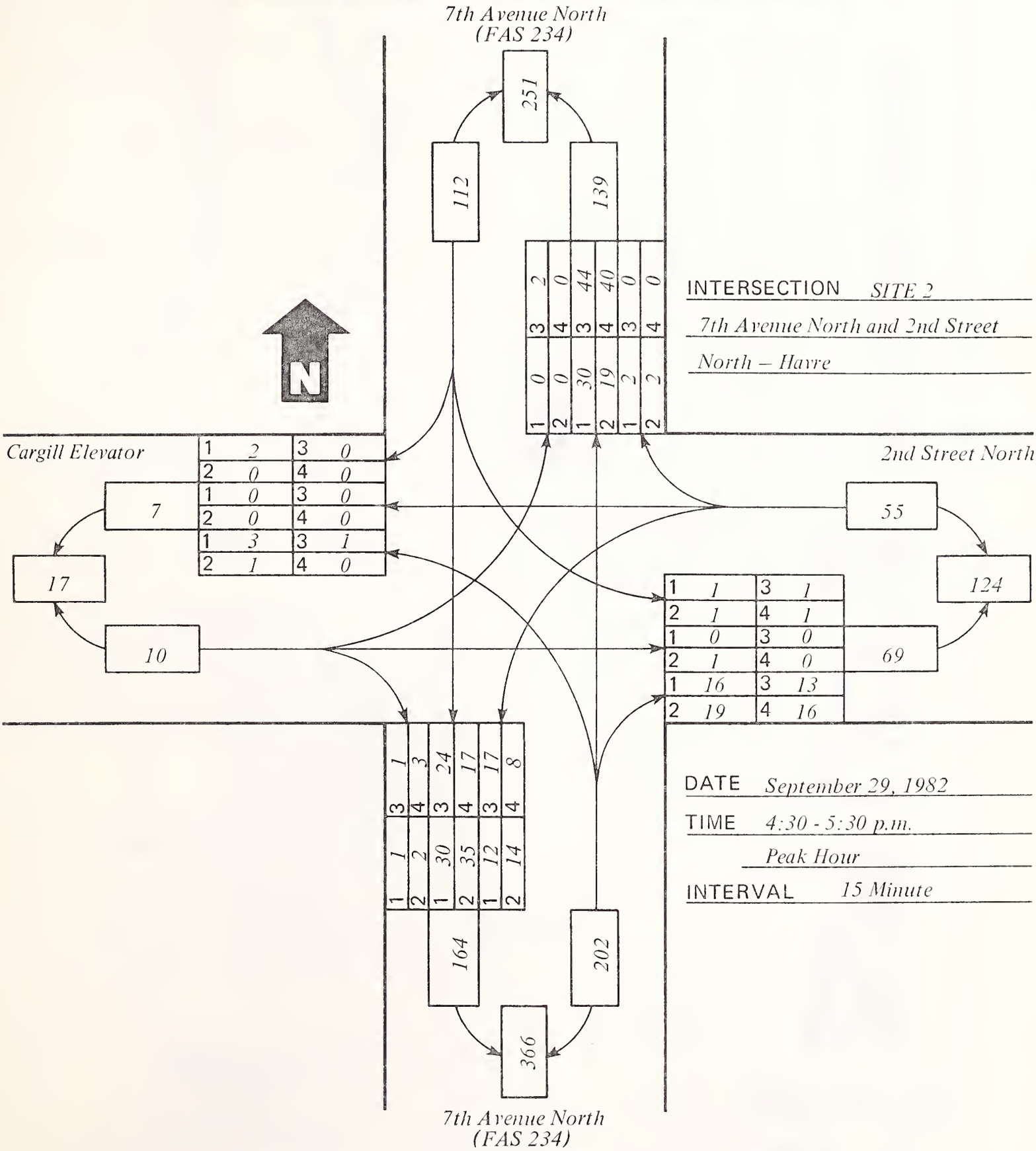
During the four-year study period, pedestrians were involved in only one accident at the site. A pedestrian was walking with traffic on the inside of the curve and was struck and injured by a passing truck. Based on field observations, it is evident that the roadway is frequently used by pedestrians, even though pedestrian facilities are lacking. This situation is quite dangerous, and provisions for pedestrians seem warranted. The composite collision diagram for this site is depicted in Figure 2C.

The accident rate at Site #2 is 11.3 accidents per million vehicles entering (MVE).

D. Recommendations

This site has several built-in problems due to the geometrics and grade. Considering the location of the residences and other buildings, it does not seem feasible to reroute this section of road to achieve a better alignment or grade. According to the accident history, icy roads and the lack of adequate sight distance have been contributory factors in the majority of the reported accidents.

TURNING MOVEMENTS



INTERSECTION *SITE 2*

7th Avenue North and 2nd Street

North – Havre

DATE *September 29, 1982*

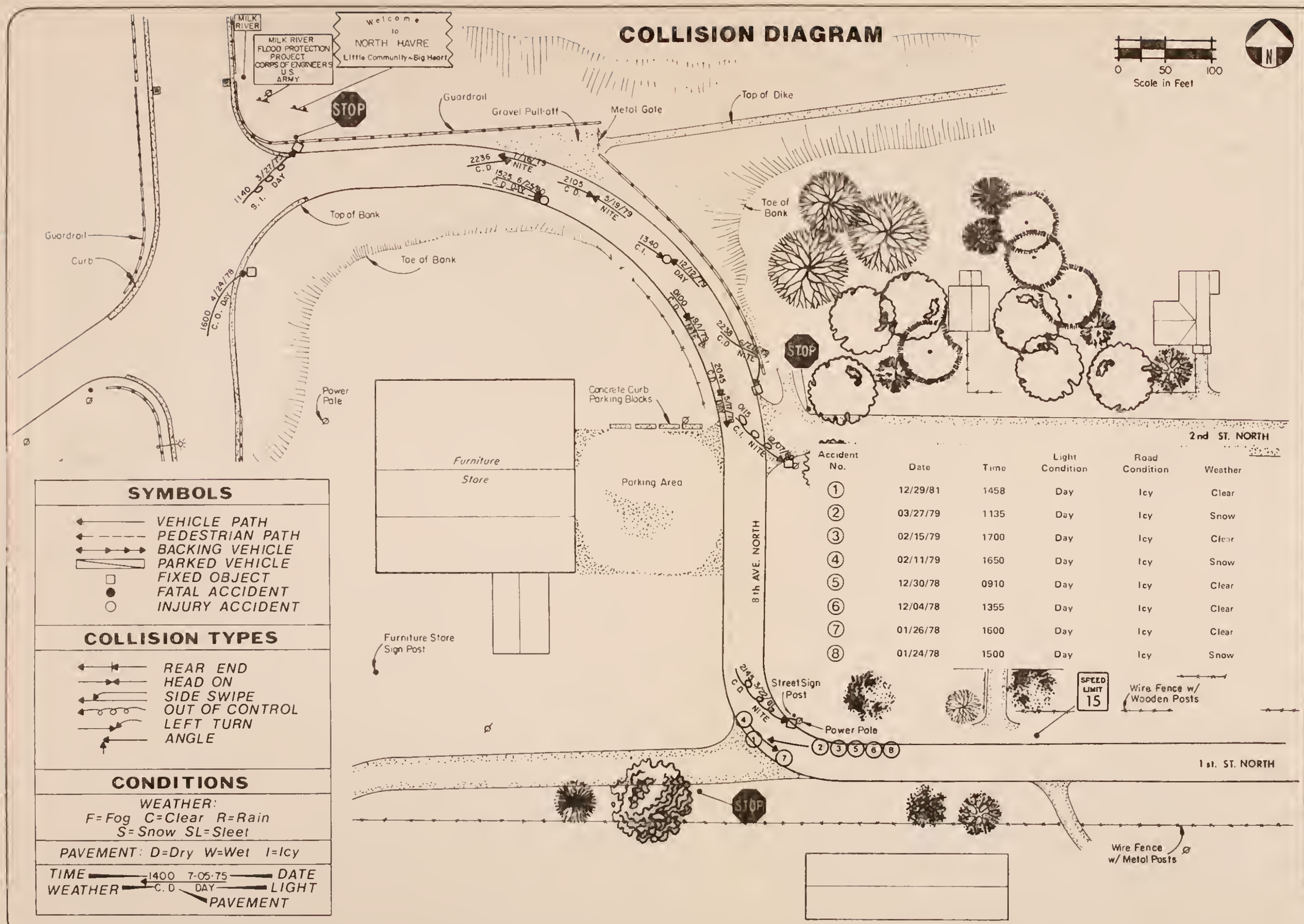
TIME *4:30 - 5:30 p.m.*

Peak Hour

INTERVAL *15 Minute*

Robert Peccia & Associates

COLLISION DIAGRAM



Accident No.	Date	Time	Light Condition	Road Condition	Weather
1	12/29/81	1458	Day	Icy	Clear
2	03/27/79	1135	Day	Icy	Snow
3	02/15/79	1700	Day	Icy	Clear
4	02/11/79	1650	Day	Icy	Snow
5	12/30/78	0910	Day	Icy	Clear
6	12/04/78	1355	Day	Icy	Clear
7	01/26/78	1600	Day	Icy	Clear
8	01/24/78	1500	Day	Icy	Snow

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME — 1400 7-05-75 — DATE
WEATHER — C. D — DAY — LIGHT
PAVEMENT

8th AVENUE NORTH

Site No. 2

Figure No. 2-C

Hill Co.

ACCIDENT DATA

8th Avenue North

SITE NUMBER 2 ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
6	9	2	2

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2	3	4	4	3		3

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2	2	3	1	2	2	1		1			5

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2								1		2		2		3	3	1			1	1	3		

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
13	6		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
8			11	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
14		4	1

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
8		2	5	1		2		1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
8	1	5	1				3	1

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1	1	1	
Fatality				
Property Dam. Only	5	8	1	2

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

The long-term improvements involve reconstructing the curve on 8th Avenue North with a uniform superelevation and widening the inside shoulder to provide for a pedestrian walkway.

The short-term improvements are listed as follows:

1. At the intersection of 8th Avenue North and 1st Street North, the sight distance is limited by the Christian Armory Building. To reduce the problems caused by this lack of sight distance, it is recommended that a stop sign (R1-1) be installed on the east approach to the intersection. Stopping the approaching traffic on 1st Street North will enable the motorist to see the entire length of 8th Avenue North.

2. To better identify the 8th Avenue North and 1st Street North intersection, a large arrow warning sign (W1-6, 48" x 24") should be installed on the south side of the intersection. The sign should be placed so it will be visible to approaching traffic at least 500 feet from the intersection.

3. Several of the reported accidents involved collisions with the existing power pole on the northeast corner of 8th and 1st. This pole is located immediately adjacent to the roadway. It is recommended that this power pole be relocated 50 feet to the east, where it will not be near the path of turning vehicles.

4. The street sign located on the northeast corner of the 8th and 1st intersection should be relocated to the northwest corner. This sign has been struck several times, according to the accident records. In its new location, the street sign will be just as effective but will minimize the chance of being involved in a collision.

5. Many of the reported accidents at this site involved icy roads; therefore, it is recommended that icy road warning signs (W8-8) be installed. One sign should be placed 500 feet east of the 8th and 1st Street intersection, and the other should be located approximately 150 feet east of the 7th and 8th Street intersection. The signs should be hinged so that they can be folded down during the summer months.

It is strongly recommended that the County continue to sand this site as often as necessary during the winter months. According to the County Road Superintendent, the curve on 8th Avenue North is high on the priority list for sanding and is sanded several times a day when ice is present.

6. A reverse turn sign (W1-3R) and a 10 mph advisory speed plate (W13-1) should be installed approximately 100 feet east of the intersection of 8th and 7th Avenues. A ball bank indicator test was used to determine that 10 mph is the appropriate, safe speed for this combination of curves.

7. A turn warning sign (W1-1L) and a 15 mph advisory speed plate (W13-1) should be installed on the east side of 8th Avenue North approximately 200 feet north of the 1st Street North intersection. The 15 mph speed was determined by using a ball bank indicator.

8. The guard rail on the outside of the curve along 8th Avenue North should be modified. A wrap-around end section of guard rail should be added to the south end.

9. A series of bi-directional silver reflectors (Design "C", 4" x 4") should be placed along the outside of the curve on 8th Avenue North. The reflectors should be placed directly behind the existing guard rail and adjusted so that the reflectors will lead motorists through the curve from both directions.

10. According to the collision diagrams, 11 of the 19 reported accidents were two-vehicle accidents in which one or both vehicles were not in their proper lane. This section of road receives centerline paint striping through an annual striping program; unfortunately, during most of the year the markings are difficult to see due to wear. It is recommended that the pavement marking of this site be conducted at least twice a year. The markings should include a double solid yellow centerline through the entire site. The centerline should be dashed through the curve at the 8th and 1st intersections as shown in Figure 2D. Painted stop bars should be installed adjacent to the stop signs as indicated.

11. Both the stop sign for the 2nd Street approach and the stop sign on the west approach to the 8th and 1st Street intersection are obscured by tree branches. These branches should be pruned back so the stop sign on 2nd Street is clearly visible for a minimum of 250 feet and the stop sign on the approach to 8th and 1st is visible for at least 500 feet.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Install Stop Sign (R1-1)	$130	$130
1	ea	Install Large Arrow Warning Sign (W1-6, 48" x 24")	$163	163
1	ea	Relocate Street Sign	$60	60
2	ea	Install Icy Road Warning Signs (Hinged Type) (W8-8)	$150	300
1	ea	Install Reverse Turn Warning Sign (W1-3R) and 10 mph Advisory Speed Plate (W13-1)	$180	180

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Install Turn Warning Sign (W1-1L) and 15 mph Advisory Speed Plate (W13-1)	$180	$180
1	ea	Install Wrap-Around End Section of Guard Rail	$100	100
12	ea	Install Reflectorized Delineators (Design "C", 4" x 4", silver)	$18	216
2	ea	Install Painted Stop Bar	$20	40
3,000	lf	Paint Striping, 4" wide, solid	$.04/lf	120
-	Lump Sum	Prune Tree Limbs	-	200
TOTAL COST:				$1,689

BENEFIT/COST RATIO: 12.3

Long-Term Improvements

The curve on 8th Avenue North has a non-uniform superelevation that tends to pitch vehicles to the outside of the curve. This makes it very difficult for motorists to maintain position in the proper lane. The only way to alleviate this design flaw is to reconstruct the curve. This can be accomplished during resurfacing by adjusting the road section to achieve a uniform superelevation throughout the curve. A 0.2 foot per foot superelevation is recommended.

The shoulder of the road on the inside of the curve along 8th Avenue North should be widened approximately four feet to accommodate a pedestrian walkway. It should be noted that a child was injured in a hit and run accident while walking along the shoulder of the road.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1,067	sy	Reconstruct Curve to Uniform Superelevation (400 ft.)	$7.50	$8,003
1,000	cy	Widen Shoulder (Fill Material)	$2.50	2,500
TOTAL COST:				$10,503

RECOMMENDED IMPROVEMENTS

Site No. 2 — 8th AVENUE NORTH

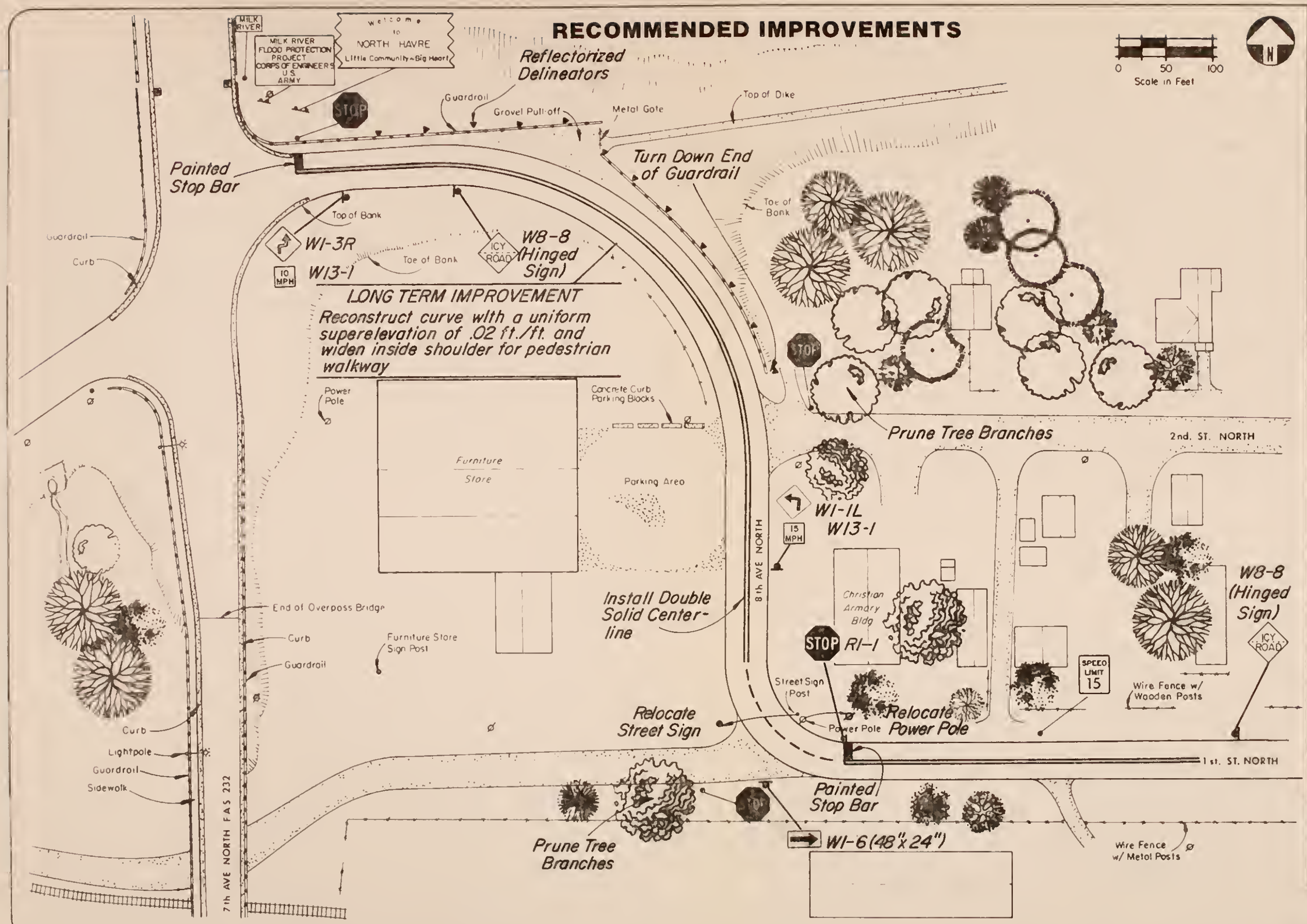


Figure No. 2-D
Hill Co.

DETERMINATION OF HAZARD INDEX

Site Number *2* Date *December, 1982*

Site Description *8th Avenue North*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*4.75* acc/yr	*56*	x 0.164 =	*9.18*
Accident Rate	*11.3* acc/MVE	*100*	x 0.225 =	*22.5*
Accident Severity	*5,374* dollars	*49*	x 0.191 =	*9.36*
Volume/Capacity Ratio	*0.16*	*34*	x 0.082 =	*2.79*
Sight Distance Ratio	*0.83* (wt. avg.)	*49*	x 0.074 =	*3.63*
Driver Expectancy	*6.0* (wt. avg.)	*100*	x 0.149 =	*14.90*
Information System Deficiencies	*6.0* (wt. avg.)	*100*	x 0.115 =	*11.50*

Hazard Index: *73.86*

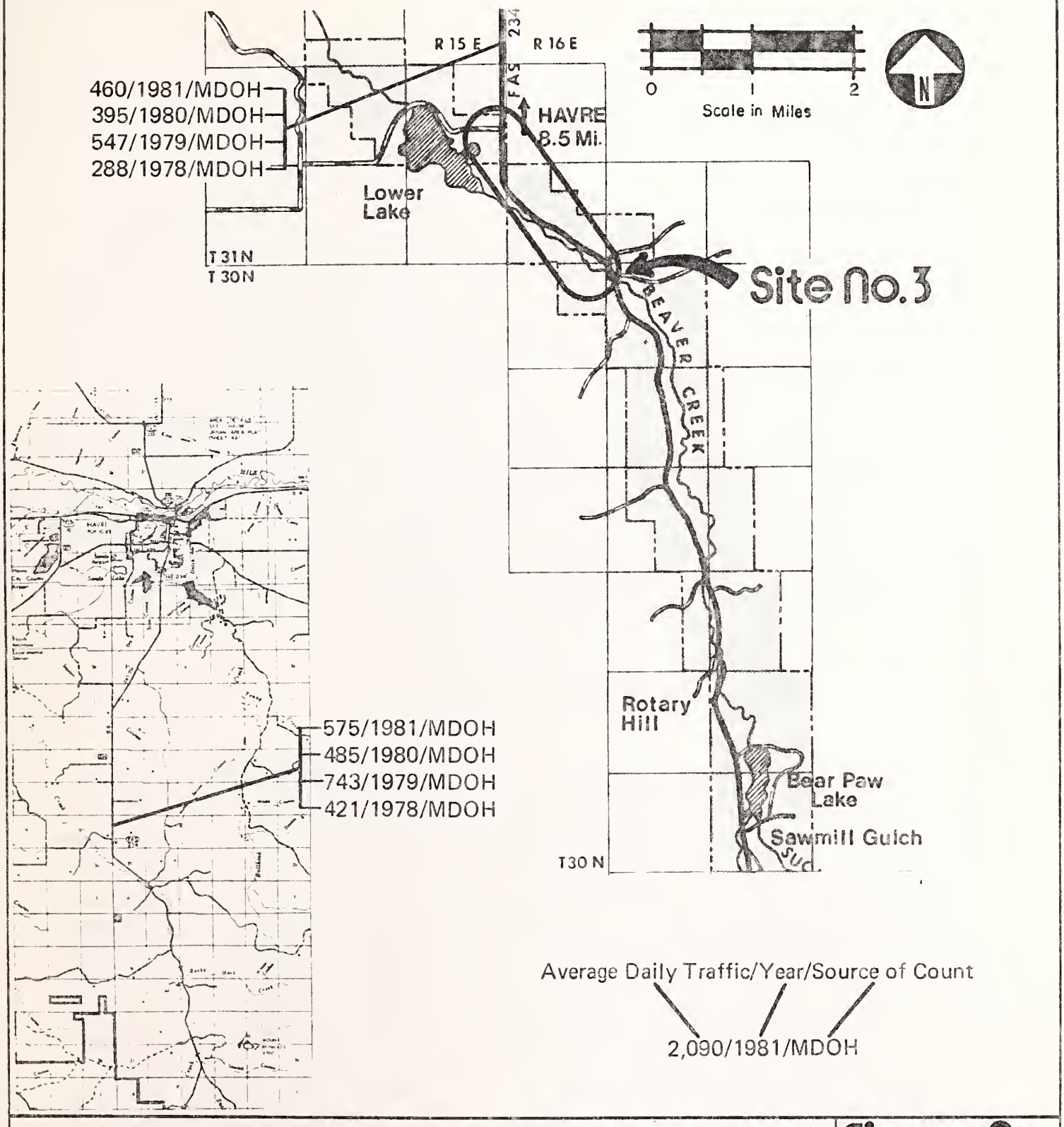
Cost of Recommended Improvements: *$1,689*

Cost Factor: *98*

Priority Index = Hazard Index x .75 + Cost Factor x .25

73.86 x .75 + *98* x .25 = *79.9*

Site no. 3



SITE LOCATION
TRAFFIC COUNTS
NORTH BEAVER CREEK PARK

Figure No.
3-A
Hill Co.

SITE #3

Beaver Creek Road (FAS 234)
North Beaver Creek Park

A. Location

Site #3 includes the initial 2.2 miles of Beaver Creek Park, a park administered and maintained by Hill County. The long, narrow recreation area begins approximately 8.5 miles south of the Havre city limits and follows Beaver Creek for nearly 17 miles. The road carries primarily recreational travel during the spring and summer months and occasionally during the winter by visitors to a local ski area located in the Bear Paw Mountains in the southern portion of Hill County. The remainder of the year, traffic declines significantly and is comprised mostly of local residents. The roadway initially passes through open, rolling terrain and then into relatively flat terrain with heavy roadside vegetation of shrubs and trees. A review of all accidents over the entire length of Beaver Creek Road during the study period indicated that considerably more accidents have occurred on the initial 2.2 miles of roadway within Beaver Creek Park than elsewhere over the length of the road. Due to the similar nature of the road and the fact that accidents are not confined to one specific location within the stretch, this site will be discussed in relatively general terms. The site location and existing traffic count data is presented in Figure 3A.

B. Existing Conditions

Beaver Creek Road (FAS 234) was reconstructed in 1973 and has an asphalt pavement surface 26 feet in width. Pavement markings within the section delineate two 12-foot driving lanes and 1-foot-wide shoulders. The roadway is constructed through gently rolling terrain where grades range from one to eight percent, and through the relatively flat bottomland of Beaver Creek. Because Beaver Creek Road follows the creek bottom for much of its length, the roadway has many curves. Very few of these curves have been specifically identified or signed with curve warning signs. A general signing policy of Hill County has been to place curve warning signs (W1-5) on each approach to a major series of curves. The posted speed limit for this section of Beaver Creek Road is 45 miles per hour. Ball bank tests conducted over the length of the site indicated that this posted speed is quite comfortable and appropriate for most areas. The roadway crosses Beaver Creek near the southern end of the site, one of many bridges along the entire length of Beaver Creek Road. The wooden bridges were generally built during the 1930's and have been surfaced with asphalt pavement. These bridges are in good condition; however, they are quite narrow. Bridge and object markers on the bridge within Site #3 are not matching and vary in stripe width. Other warning signs typical to this site are "School Bus Stop Ahead" signs and non-standard "Cattle on Road" signs manufactured by Hill County.

Existing Site Conditions

Signing and striping on Beaver Creek Road. Note non-standard "Cattle on Road" sign and basically unlimited sight distance typical to much of this site.

Typical area within site where roadside vegetation has been cut back through a Hill County maintenance program. This practice reduces the "hiding places" for cattle or deer near the roadway and allows cattle to move along the roadway shoulder rather than on the roadway itself.

Note gently rolling terrain common to this portion of Beaver Creek Road and cattle hidden from the view of oncoming drivers by dense vegetation.

Typical situation facing driver passing through this section of Beaver Creek Park.

Plate 3

Undoubtedly the single most hazardous situation associated with this roadway results from cattle on or near the roadway. Area ranchers frequently graze cattle within Beaver Creek Park through leasing arrangements with Hill County. This practice provides Hill County with a major source of revenue for operation and maintenance of the park throughout the year. Due to the cost of park operations, this policy can be expected to continue. A contributing factor to the hazard of cattle on or near the roadway is the thickness of roadside vegetation, which forces cattle to move along the shoulder where walking is much easier. Hill County recently initiated a policy of trimming back vegetation approximately 15 feet from the edge of the roadway. This practice makes cattle more visible to motorists and reduces the number of "hiding spots" near the roadway edge. In addition, the trimming of roadside vegetation has also served to increase sight distance in some instances. Typical site conditions are depicted in Plates 3A and 3B.

Traffic counts are taken annually at two locations on Beaver Creek Road by the Montana Department of Highways. Average daily traffic (ADT) is determined through the use of 24-hour machine counts of traffic volumes. The 1981 ADT for Beaver Creek Road varies from 575 vehicles per day south of Havre to 460 vehicles per day near the entrance to Beaver Creek Park.

C. Accident History

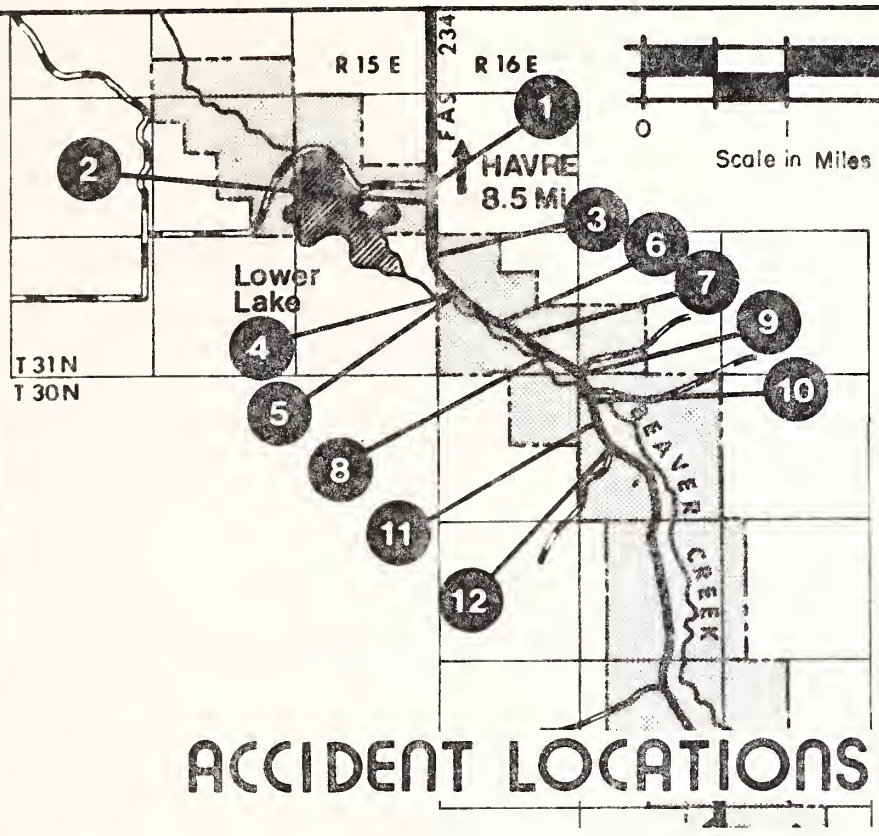
During the 1978-1981 study period, twelve accidents occurred in the initial 2.2 miles of Beaver Creek Park south of Havre. All but two of the accidents at this site were single-car accidents, and two of the twelve accidents resulted in injuries to a total of two people. Three-fourths of the accidents occurred during dusk or at night under clear and dry weather and road conditions. Six of the twelve accidents reported at this site during the study period resulted when animals were struck by vehicles. These accidents occurred during the late evening or nighttime hours when visibility was limited, and are primarily the result of the open cattle grazing which is practiced within the park. Major factors contributing to accidents at this location are excess speed and alcohol. Accident locations in the North Beaver Creek Park area are depicted in Figure 3B.

The accident rate for the North Beaver Creek Park road is 17.9 accidents per million vehicles entering.

D. Recommendations

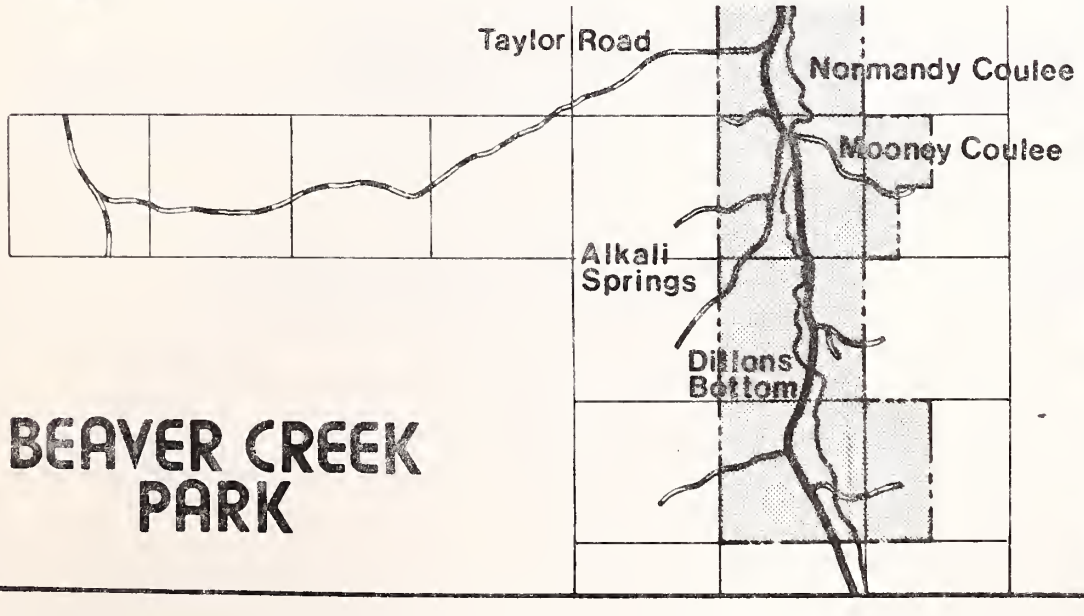
This portion of Beaver Creek Road is relatively straight with only minor curves connecting the long tangent sections. This 2.2 miles of road is very similar to much of the other 21 miles of Beaver Creek Road, but according to accident records, this section has several times the accident rate of the entire Beaver Creek Road. The short-term improvements for this site are as follows:

1. In the summer of 1982, the County began a program of cutting back vegetation to 15 feet from the edge of the roadway. This is by far the most effective means of reducing vehicle/animal collisions. It is strongly recommended that this type of maintenance be continued in the future. According



ACCIDENT LOCATIONS

Accident No.	Date	Time	Light Condition	Road Condition	Weather
1	01/29/78	1130	Day	Icy	Snow
2	08/11/78	2200	Night	Dry	Clear
3	04/28/79	2300	Night	Dry	Clear
4	10/02/79	0045	Night	Dry	Clear
5	09/20/80	2015	Night	Dry	Clear
6	06/08/80	2145	Dusk	Dry	Clear
7	08/31/79	2200	Night	Wet	Clear
8	07/15/79	1930	Day	Dry	Clear
9	08/26/78	0500	Night	Dry	Clear
10	05/22/79	2330	Night	Dry	Clear
11	11/02/81	1925	Night	Dry	Clear
12	07/02/78	0100	Night	Dry	Clear



BEAVER CREEK PARK

Site No. 3

NORTH BEAVER CREEK PARK

Figure No. 3-B

Hill Co.

ACCIDENT DATA

Beaver Creek Road (FAS 234); North Beaver Creek Park

SITE NUMBER 3 ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
4	5	2	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
5		2			2	3

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1			1	1	1	2	3	1	1	1	

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1				1						1								2	1	1	2	2	1

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
3	8		1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
10	1		1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
11		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
		1	1		6	1	3		

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
6	3		2					1

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury		2		
Fatality				
Property Dam. Only	4	3	2	1

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

3

to AASHTO in their safety design standards for highway systems, the optimum setback distance for this type of dense brush is 30 feet. By clearing a 30-foot-wide shoulder on each side of the roadway, the motorist is given a much greater chance of locating animals adjacent to the road. In addition, the grass along the roadway shoulder in this cleared area should be frequently cut or sprayed to deter growth. This would minimize the amount of grazing and thereby reduce the number of cattle feeding along the edge of the road. It is realized that the Park Board is against cutting the brush back any more than 15 feet at this time.

2. Two-thirds of the reported accidents occurred during the nighttime hours. Although the roadway has centerline and shoulder stripes, these stripes become less effective when worn, and totally ineffective in heavy rain or snow. Reflectorized delineators spaced along this section would aid the motorist in identifying the roadway during the night.

Single-faced reflectorized delineators (Design "A", 4" x 4", silver) should be placed off the right shoulder with a typical spacing of 500 feet in tangent sections.

Within the limits of this study site there are two gentle curves, one located approximately 1.0 mile from the northern entrance to the park and the other approximately 2.1 miles south of the north entrance. These curves should be delineated with double-faced adjustable reflectors (Design "C", 4" x 4"). These reflectors should be placed on the outside of the curve with a spacing of approximately 75 feet.

3. Two different types of object markers (OM-3) are being used to identify the ends of bridge railings. Although both types of markers are three feet by one foot in size, one has six-inch stripes and the other has four-inch stripes. Both are acceptable according to the Manual on Uniform Traffic Control Devices; but when object markers are used in pairs, the two signs should have the same stripe width. It is recommended that the County establish a policy of correcting the mismatched pairs of object markers when the replacement of one or both signs is required.

The existing signing practice for cattle crossings appears to be effective. However, a non-typical green and white advisory plate is currently being used with the standard cattle crossing warning signs (W11-4), and it is recommended that this practice be discontinued. The more appropriate and widely accepted yellow and black advisory plate (W11-4P, 24" x 18") should be used in conjunction with the cattle crossing warning sign (W11-4). The advisory plate should never be used alone.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
40	ea	Reflectorized Delineators (Design "A", 4" x 4", silver)	$15	$600
20	ea	Reflectorized Delineators (Design "C", 4" x 4", silver)	$18	360
TOTAL COST:				$960

BENEFIT/COST RATIO: 1.9

Long-Term Improvements

Of the 12 reported accidents occurring in this 2.2-mile section of Beaver Creek Road, half were caused by collisions with animals on the road. The open range grazing of cattle that is presently the standard within the park is creating a serious hazard to motorists. Although animal collision accidents occur in other parts of the park, this section of road has a much higher rate of occurrence of such accidents than any other section of Beaver Creek Road.

The optimum long-term solution to the cattle problem at this site involves fencing both sides of the roadway, allowing the cattle to cross only at well-marked crossings. The fence should be installed at the edge of an 30-foot clear zone as defined in short-term improvement #1. The crossings should be approximately one-quarter mile long and enclosed by cattle guards at either end. One crossing could be placed at the northernmost end of the Park, thereby utilizing the existing cattle guard as one end. These designated crossings should be signed with cattle crossing warning signs (W11-4). Supplemental plaques (W7-3a) reading "Next $\frac{1}{4}$ Mile" should be used in conjunction with the warning signs.

These designated crossings should be located in the middle of long tangent sections of road where sight distance is at a maximum.

The anticipated cost of this improvement is $28,740.

It is understood that the present Park Board is against any fencing along the road in this portion of Beaver Creek Park. The improvement outlined above is considered the optimum solution, and is by no means the only solution. Perhaps the cattle can be kept off the road by fencing in other portions of the park back from the road, or by changing the present grazing policy to restrict grazing to certain portions of the park where cattle will not present a problem to traffic. It is strongly recommended that the Park Board examine all possible alternatives that would prevent the conflict between cattle and motor vehicles in the park.

DETERMINATION OF HAZARD INDEX

Site Number *3* Date *December, 1982*

Site Description *Beaver Creek Road; North Beaver Creek Park*

Indicator	Data Value		Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*3.0*	acc/yr	*45*	x 0.164 =	*7.38*
Accident Rate	*17.9*	acc/MVE	*100*	x 0.225 =	*22.5*
Accident Severity	*10,417*	dollars	*64*	x 0.191 =	*12.22*
Volume/Capacity Ratio	*0.14*		*32*	x 0.082 =	*2.62*
Sight Distance Ratio	*0.84*	(wt. avg.)	*49*	x 0.074 =	*3.63*
Driver Expectancy	*2.5*	(wt. avg.)	*41.7*	x 0.149 =	*6.21*
Information System Deficiencies	*3.0*	(wt. avg.)	*50.0*	x 0.115 =	*5.75*

Hazard Index: *60.31*

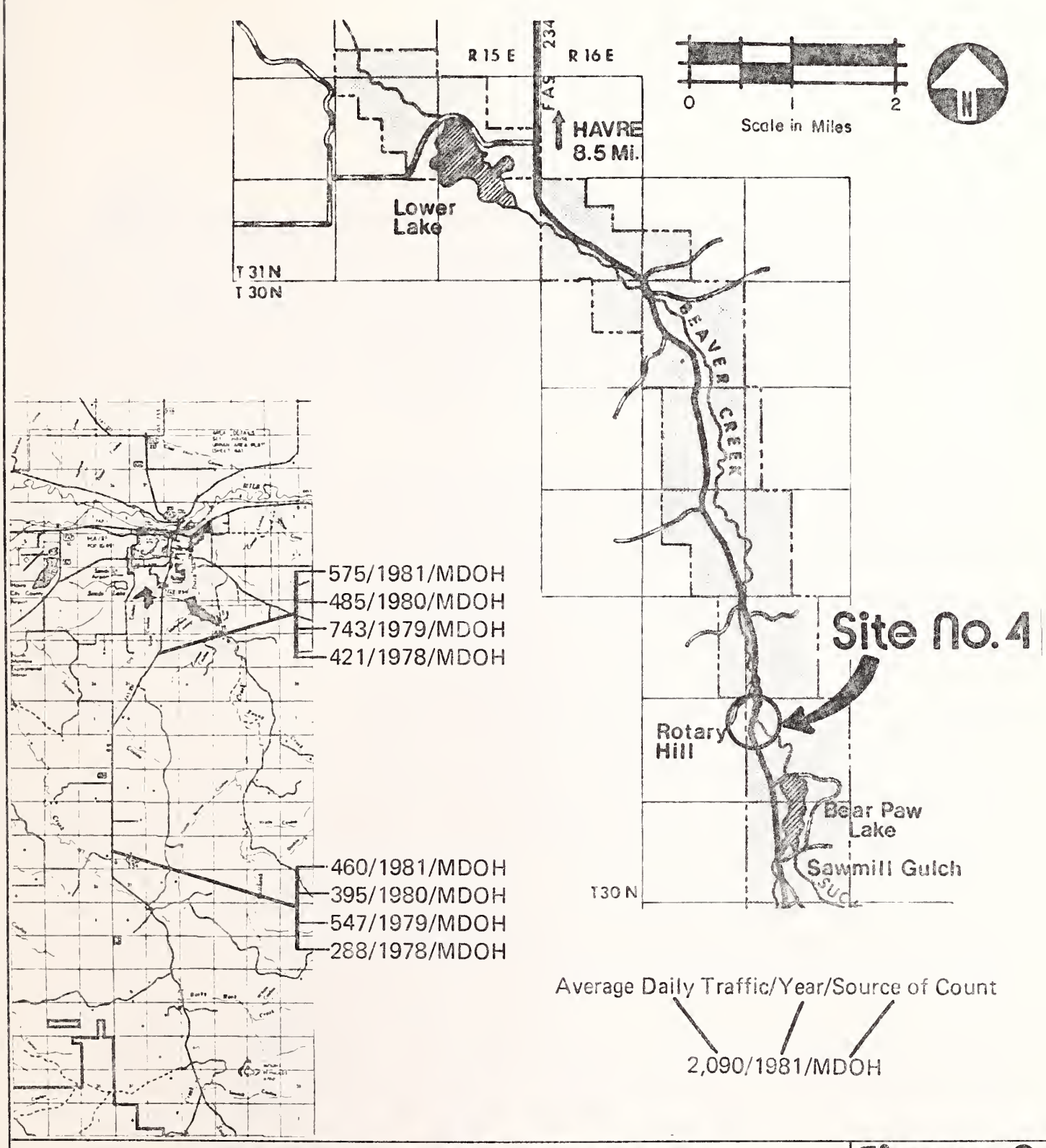
Cost of Recommended Improvements: *$960*

Cost Factor: *98*

Priority Index = Hazard Index x .75 + Cost Factor x .25

60.31 x .75 + *98* x .25 = *69.7*

Site no.4



SITE LOCATION
TRAFFIC COUNTS
BEAVER CREEK PARK

Figure No.
4-A
Hill Co.

SITE #4

Beaver Creek Road at Rotary Hill

A. Location

Site #4 includes approximately one-half mile of the Beaver Creek Road (FAS 234) 14.5 miles south of the Havre City Limits. The site is located within Beaver Creek Park and consists of a long, steep grade locally known as Rotary Hill. The site is located in an area that is used quite extensively during the summer for recreation and camping. During the fall, the area is used as range for cattle. The location of Rotary Hill and the existing traffic count data for Beaver Creek Road are depicted in Figure 4A.

B. Existing Conditions

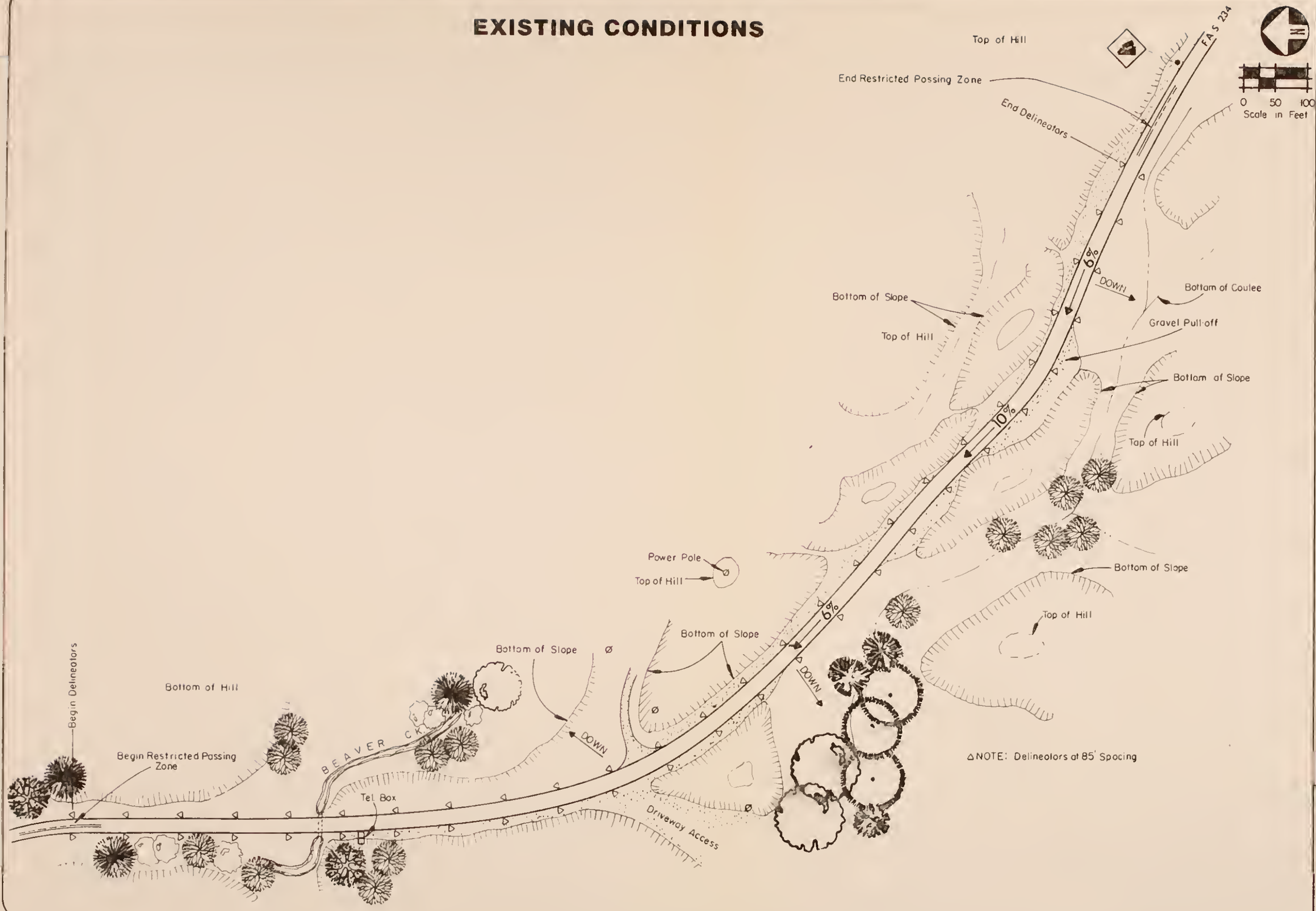
The asphalt-paved roadway of Site #4 has a general width of 26 feet. The roadway is marked with a double solid centerline and shoulder stripes delineating two 12-foot driving lanes and shoulders varying in width between one and two feet. Grades on Rotary Hill are constant at six percent; however, one short section in the middle of the site has a grade of approximately ten percent. The road alignment changes approximately 80 degrees through the broad curve at this site. The posted speed limit for all sections of Beaver Creek Road within the park is 45 mph. No speed limit signs or advisory speed signs are located near this site. Signing at the site is limited to a "Hill" warning sign (W7-1) which is located on the south approach to the site. The hill is extensively lined with flexible delineators. These delineators are extremely beneficial through the curves on the hill; however, additional delineation is required in the tangents to the curves to more effectively guide the motorist through the site. Obstructions are more than six feet off the roadway. There are several areas throughout the site where steep coulees are within 25 feet of the edge of the roadway. These areas present a very hazardous situation, especially since no protective guard rail has been installed. A crest in the hill, where the grade changes from six to ten percent, tends to limit sight distance somewhat for northbound motorists. The site is depicted in Figure 4B and Plate 4.

Based on traffic counts conducted by the Montana Department of Highways, the ADT was determined to be 460 vehicles per day. Traffic during the fall and winter is expected to be considerably less.

C. Accident History

A total of four accidents, all of which occurred during 1978, were reported in the Rotary Hill area during the study period. These accidents resulted in injuries to one person. Local officials have indicated that numerous accidents, including one fatality, have occurred at this site during the past few years. These accidents appear to be either unreported or beyond the limits of the accident study period. All of the four reported accidents were

EXISTING CONDITIONS



BEAVER CREEK ROAD
AT ROTARY HILL

Site No. 4

Figure No.
4-B
Hill Co.

Existing Site Conditions

Looking at the north approach to Rotary Hill. Delineators spaced approximately 90 feet apart.

Looking northward through the site. Note the paths established along the roadway, indicating cattle movements.

Looking north through the site from near the top of Rotary Hill. Note the steep banks adjacent to roadway shoulder and condition of several roadside delineators. The delineators appear to have been damaged when roadside vegetation was trimmed.

View of north approach to Rotary Hill. Note pavement markings and the high visibility of roadside delineators.

Plate 4

COLLISION DIAGRAM

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

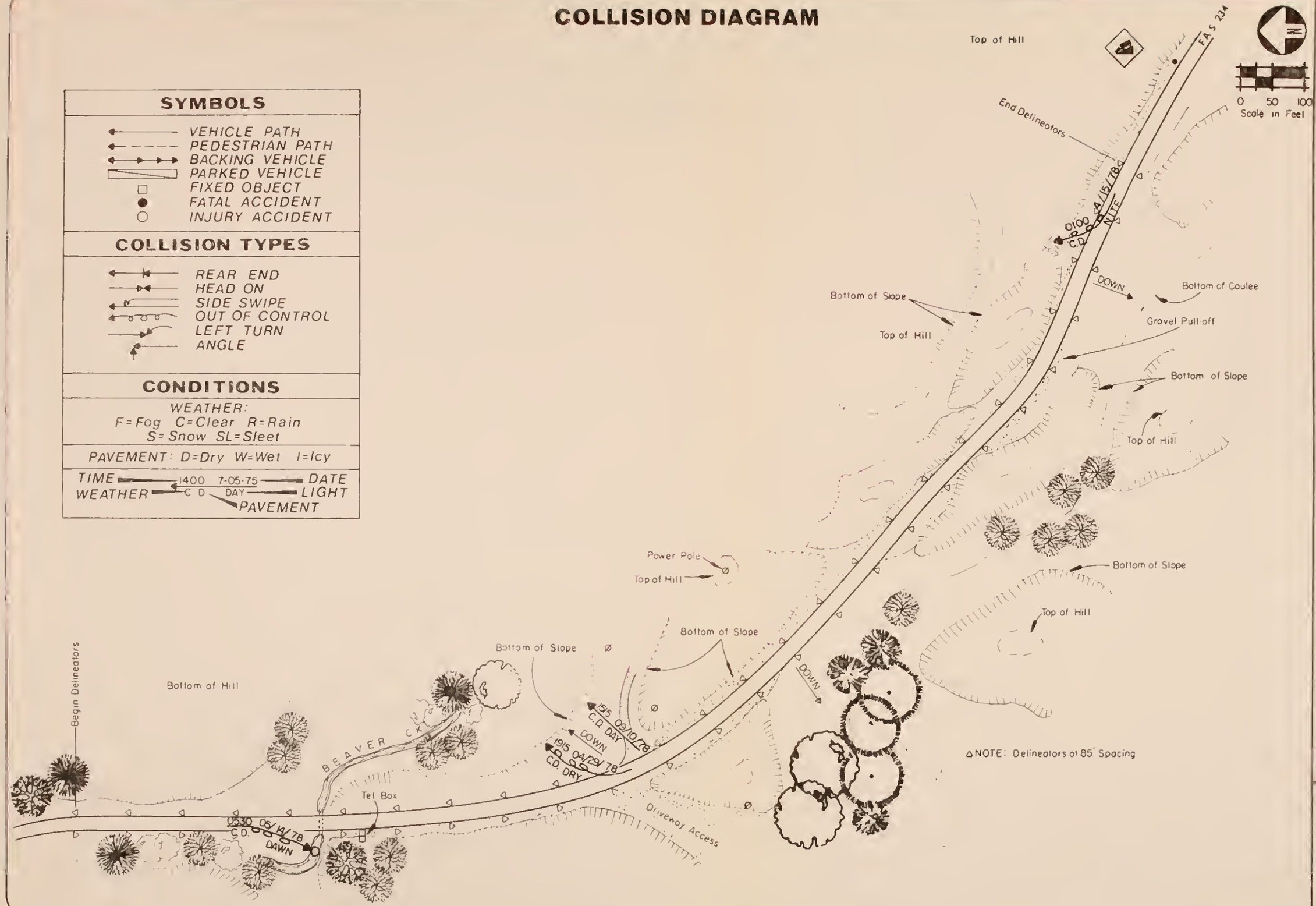
- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME 1400 7-05-75 DATE
WEATHER C D DAY LIGHT
PAVEMENT



BEAVER CREEK ROAD
AT ROTARY HILL

Site No. 4

Figure No. 4-C

Hill Co.

ACCIDENT DATA

Beaver Creek Road at Rotary Hill

SITE NUMBER 4 ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
4			

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	1					2

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			2	1				1			

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1				1										1				1					

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
2	1	1	

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
4				

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
4			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			4						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1			2					1

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1			
Fatality				
Property Dam. Only	3			

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

0

single-vehicle, fixed-object accidents that involved a loss of control by the driver. The accidents generally occurred under clear and dry weather and road conditions, and were the result of excess speed and the inability to negotiate the curves. Three of the accidents were vehicle rollovers caused by the steepness of the roadway edge. Sections of Rotary Hill have steep embankments within fifteen feet of the roadway. Slopes in these areas vary from a minimum of 3:1 to 1:1 or greater, and significantly increase the chances of a vehicle rollover if a motorist leaves the roadway. Figure 4C depicts the composite collision diagram for this site.

The accident rate at this site is 6.0 accidents per million vehicles entering.

D. Recommendations

This particular section of Beaver Creek Road has a grade varying from six to ten percent. The shoulders of the road drop off into deep coulees, which tends to compound the severity of an accident. The short-term improvements listed below are intended to alert motorists to the road conditions at this site.

1. The existing delineation system consists of white, flexible delineator posts. Although they do identify the roadway, the spacing of the delineators is not in accordance with the Manual on Uniform Traffic Control Devices. At present, delineators are spaced approximately 85 feet apart. It is recommended that several groups of delineators be removed and reinstalled in the reverse curves immediately north of Rotary Hill. By removing several delineators, a better spacing pattern can be achieved.

The intent is to lead the motorist through the curves and up the hill. Delineator spacing should become progressively closer on the curve approach and should be the most tightly spaced in the curve itself. The delineators should be spaced further apart in the tangent sections. It is important to use the delineator spacing to define the most critical sections of the roadway.

The delineators should be carefully removed so that they are not damaged, and reinstalled in the reverse curve section of the road immediately north of the site. These curves should be defined by using a 90-foot delineator spacing in the curves themselves, with the spacing increasing to 180 feet and then 240 feet on the tangent approach sections. Such a pattern will help to guide the motorist through the entire critical area beginning in the tangent approach to the north, continuing through the curve, and up the hill to the tangent section to the south.

2. The "Hill" warning sign (W7-1) located on the south approach is appropriate. By using a ball bank indicator, the safe travelling speed for this section of road was determined to be 35 mph. Therefore, it is recommended that the existing "Hill" warning sign be supplemented with a 35 mph advisory speed plate (W13-1).

3. The reverse curves just north of Rotary Hill should be identified through the use of reverse turn warning signs (W1-4L). The warning signs

should be accompanied by 35 mph advisory speed plates (W13-1). The signs should be installed approximately 750 feet back from the beginning of the curved section of road.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
16	ea	Remove and Reinstall Flexible Delineators	$15	$240
3	ea	Install Advisory Speed Plate (W13-1)	$50	150
2	ea	Install Reverse Turn Warning Signs (W1-4L)	$130	260
TOTAL COST:				$650

BENEFIT/COST RATIO: 2.7

Long-Term Improvements

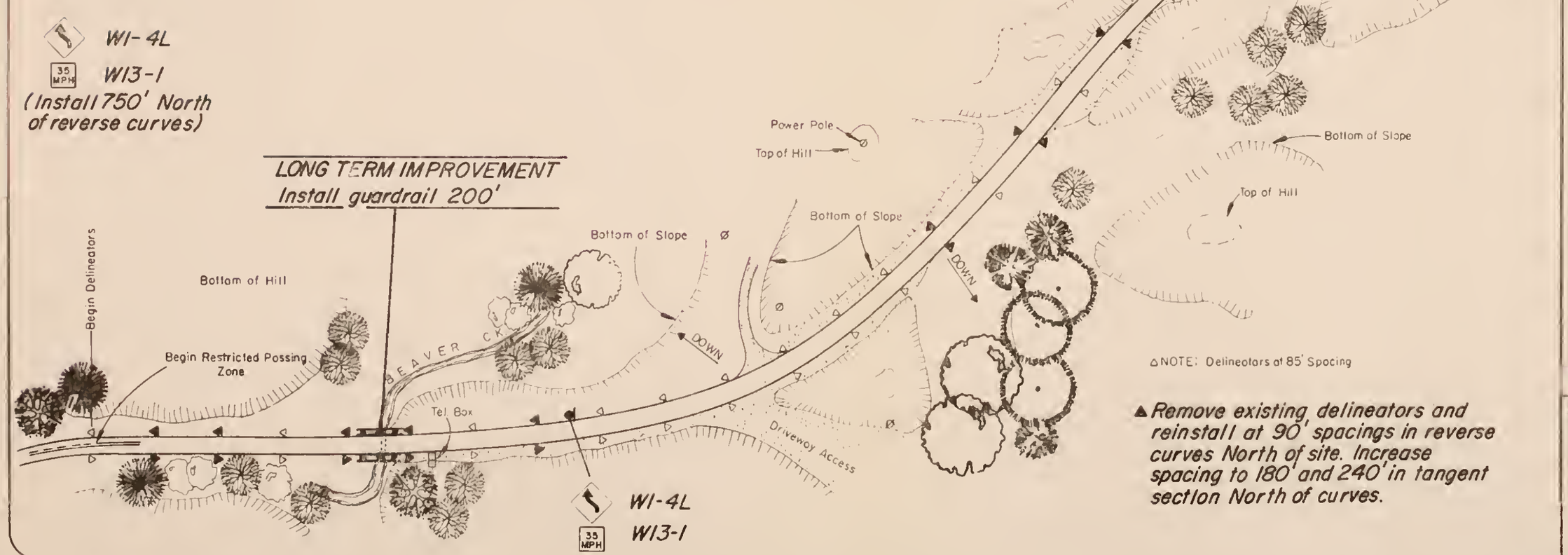
According to the County Road Superintendent, the steep banks of the road shoulder at this site have claimed several lives in the past ten years, although no fatality accidents occurred during the study period. These steep banks meet the requirements for the installation of guard rail. Therefore, it is recommended that a 350-foot-long section of guard rail be installed on the west side of Rotary Hill adjacent to the sharp drop-off, as indicated on Figure 4D. Guard rail should also be installed on both sides of the section of road over Beaver Creek at the bottom of Rotary Hill.

In addition, one section of Rotary Hill is hazardous due to the horizontal and vertical alignment. The hill changes abruptly from a grade of six percent to ten percent in a slight horizontal bend in the road. Thus a vehicle travelling north and coming down the hill is momentarily unweighted, due to the change in grade, at a time when a course correction is required. There is no superelevation in the road at this point. Therefore, it is recommended that this section of the hill be reconstructed to use a vertical curve of approximately 400 feet in length to change grades. The use of the longer vertical curve will result in a smoother, more controllable ride and will lengthen the available sight distance. A superelevation of approximately 0.02 foot per foot should be installed in the slight bend in the road at the time of reconstruction.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
550	lf	Install Guard Rail	$9	$4,950
722	sy	Road Reconstruction (250 ft.)	$10	7,220
TOTAL COST:				$12,170

RECOMMENDED IMPROVEMENTS



△NOTE: Delineators at 85' Spacing

▲ *Remove existing delineators and reinstall at 90' spacings in reverse curves North of site. Increase spacing to 180' and 240' in tangent section North of curves.*

BEAVER CREEK ROAD
AT ROTARY HILL

Site No. 4

Figure No.
4-D
Hill Co.

DETERMINATION OF HAZARD INDEX

Site Number *4* Date *December, 1982*

Site Description *Beaver Creek Road at Rotary Hill*

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.0* acc/yr	*26*	x 0.164 =	*4.26*
Accident Rate	*6.0* acc/MVE	*75*	x 0.225 =	*16.88*
Accident Severity	*9,675* dollars	*62*	x 0.191 =	*11.84*
Volume/Capacity Ratio	*0.29*	*45*	x 0.082 =	*3.69*
Sight Distance Ratio	*1.17* (wt. avg.)	*22*	x 0.074 =	*1.63*
Driver Expectancy	*2.3* (wt. avg.)	*38.3*	x 0.149 =	*5.71*
Information System Deficiencies	*4.5* (wt. avg.)	*75*	x 0.115 =	*8.63*

Hazard Index: *52.64*

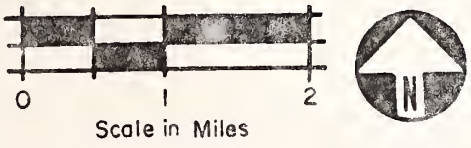
Cost of Recommended Improvements: *$650*

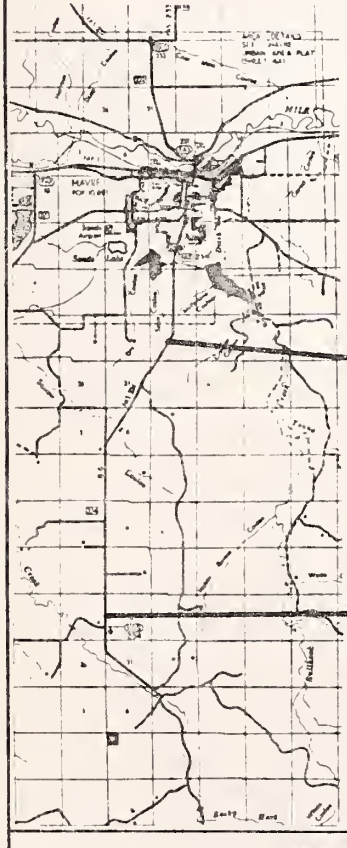
Cost Factor: *98*

Priority Index = Hazard Index x .75 + Cost Factor x .25

52.64 x .75 + *98* x .25 = *64.0*

Site no. 5





575/1981/MDOH
485/1980/MDOH
743/1979/MDOH
421/1978/MDOH

460/1981/MDOH
395/1980/MDOH
547/1979/MDOH
288/1978/MDOH

Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
BEAVER CREEK PARK

Figure No.
5-A
Hill Co.

SITE #5

Beaver Creek Road at Mooney Coulee

A. Location

Site #5 is located 19.9 miles south of the Havre City Limits on the Beaver Creek Road (FAS 234). The site is located in Beaver Creek Park and consists of a 29.5-foot-wide bridge over Beaver Creek, a curve on the south approach, and the intersection of Alkali Springs Road and Beaver Creek Road. Traffic at the site is primarily seasonal, since numerous camping and picnic sites that are used extensively during the spring and summer months are located in the area. Travel in this rural area is much less during the remainder of the year, and the area is used for cattle grazing. Figure 5A depicts the location of this site and presents the traffic count data used for analysis of the site.

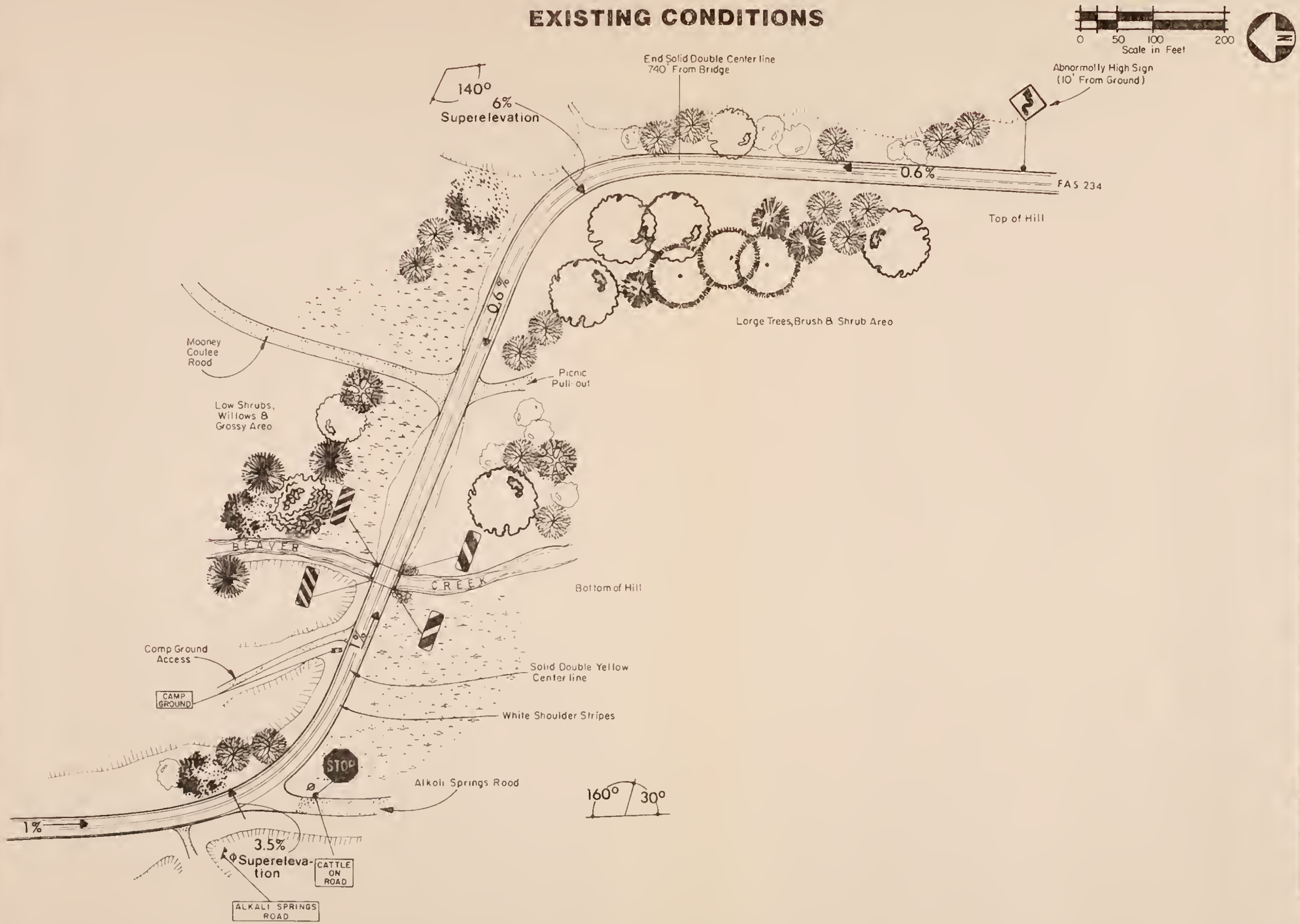
B. Existing Conditions

The asphalt-paved surface at this site is typically 26 feet wide. A double yellow centerline and white shoulder stripes delineate two 12-foot driving lanes and shoulders that are one foot wide. The southern approach to the bridge is comprised of a broad curve through a heavily wooded area. Roadway alignment changes direction by about 40 degrees on the southern approach. Approximately 300 feet north of the bridge, Beaver Creek Road is joined by Alkali Springs Road. This intersection also marks the location where the roadway alignment reverses by 20 degrees. Grades within the site vary from six percent on the southern approach to the bridge to one percent on the northern approach. Superelevations in the curves are approximately 6 percent to the inside on the southern approach and 3.5 percent to the inside on the northern approach.

The posted speed limit for Beaver Creek Road in this section is 45 mph, although no speed limit signs are located in the immediate vicinity of this site. A reverse curve warning sign (W1-5L) is located on the southern approach to the site and is mounted ten feet above the roadway surface. The Beaver Creek bridge end rails are equipped with object markers; however, the stripes on each are of differing sizes. A stop sign and a non-standard "Cattle on Road" sign are located on Alkali Springs Road. Obstructions are generally more than ten feet off the roadway surface. Sight distance is limited somewhat in the curve on the southern approach to the bridge by roadside vegetation and overhanging branches. Hill County recently initiated a program of brush clearing along the shoulders of the road, which has resulted in significant improvements in sight distance and has made cattle grazing near the roadway more visible. Site photographs and sketches are depicted in the accompanying graphics.

Machine counts of 24-hour traffic volumes were collected and analyzed for the site by Robert Peccia & Associates. Based on this data, the present ADT was determined to be 200 vehicles per day.

EXISTING CONDITIONS



BEAVER CREEK ROAD
AT MOONEY COULEE

Site No. 5

Figure No.
5-B
Hill Co.

Existing Site Conditions

View looking northward through the set of curves at the site.

Bridge over Beaver Creek near the Mooney Coulee turnoff. Note cattle on the road and the unmatched object markers at the end of the bridge.

View of curve on the south approach to the site. Note the sight distance limitations caused by roadside vegetation on the inside of the curve.

South approach to Mooney Coulee site. Note trimmed vegetation and the height at which the curve warning sign is mounted.

Plate 5

C. Accident History

A total of five accidents were reported in the Mooney Coulee area from 1978 through 1981. Four of the five accidents resulted in injuries to a total of eighteen persons. Eleven of the eighteen injuries occurred in two accidents during 1980. All five accidents occurred under clear weather conditions and on a dry pavement surface; three of the five accidents occurred between the hours of 11:00 p.m. and 4:00 a.m. All accidents reported during the study period were fixed-object accidents in which motorists lost control of their vehicles, left the roadway, and struck either road approaches or the bridge. Vehicles involved in three of the five accidents rolled over after they left the roadway surface. Excess speed, reckless driving, and alcohol involvement were all contributory circumstances in the accidents at this location. The composite collision diagram for the Mooney Coulee area is depicted in Figure 5C.

The accident rate at the Mooney Coulee site is 17.1 accidents per million vehicles entering (MVE).

D. Recommendations

This section of the Beaver Creek Road is complicated by relatively sharp reverse curves. The accident history indicates that excessive speed was a contributory factor in three of the five reported accidents. Through the use of a posted advisory speed and delineation in the curves, the safety aspects of this site can be improved. The short-term improvements are listed below.

1. The reverse curves should be better identified by installing reflectorized delineators (Design "C", 4" x 4", silver) along the outside of both curves. A spacing of 50 feet is appropriate for the northernmost curve, while a spacing of 40 feet between delineators should be used on the southernmost curve. Spacing should be increased on the tangent approaches to lead the motorists through the curves. The recommended spacing for both curves and their corresponding approaches is shown on Figure 5D.

2. It is recommended that reverse curve warning signs (W1-4L) be installed 750 feet back from the curves on both approaches. On the south approach, the existing winding road warning sign (W1-5) should be removed and replaced with the more appropriate reverse curve sign. A ball bank indicator was used to determine that 35 mph is the maximum safe speed for these curves; therefore, 35 mph advisory speed plates (W13-1) should accompany the reverse curve warning signs.

It should be noted that the mounting height of the existing winding road sign is too high. The new reverse turn signs should be mounted approximately seven feet above the road surface as recommended by the Manual on Uniform Traffic Control Devices.

3. Sight distance in the curves is somewhat limited by the adjacent trees and shrubs. It is recommended that the low branches and shrubs that restrict motorists' vision in these curves be pruned back. Trimming of roadside vegetation should be included in the annual maintenance program for this section of road.

COLLISION DIAGRAM

0 50 100 200
Scale in Feet

N

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=Icy

TIME — 1400 7-05-75 — DATE
WEATHER — C.D. DAY — LIGHT
PAVEMENT

BEAVER CREEK ROAD
AT MOONEY COULEE

Site No. 5

Figure No.
5-C
Hill Co.

ACCIDENT DATA

Beaver Creek Road at Mooney Coulee

SITE NUMBER 5 ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
1	2	2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2		1				2

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				1			2	1			1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1	1			2																	1	

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
2	3		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
5				

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
5			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			5						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
	1	1	3					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1	1	2	
Fatality				
Property Dam. Only		1		

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

3

4. The object marker panels (OM-3) that presently delineate the bridge ends should be removed and reinstalled so that the two panels that face the approaching motorist are of the same design. Both types of object markers currently in use are acceptable, but to avoid confusion, similar panels should be used when installed as a pair.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
21	ea	Install Reflectorized Delineators (Design "C", 4" x 4", silver)	$18	$378
1	ea	Remove Winding Road Warning Sign (W1-5)	$30	30
2	ea	Install Reverse Curve Warning Signs (W1-4L)	$130	260
2	ea	Install Advisory Speed Plate	$50	100
-	Lump Sum	Trim Tree Branches and Shrubs	-	250
TOTAL COST:				$1,018

BENEFIT/COST RATIO: 12.1

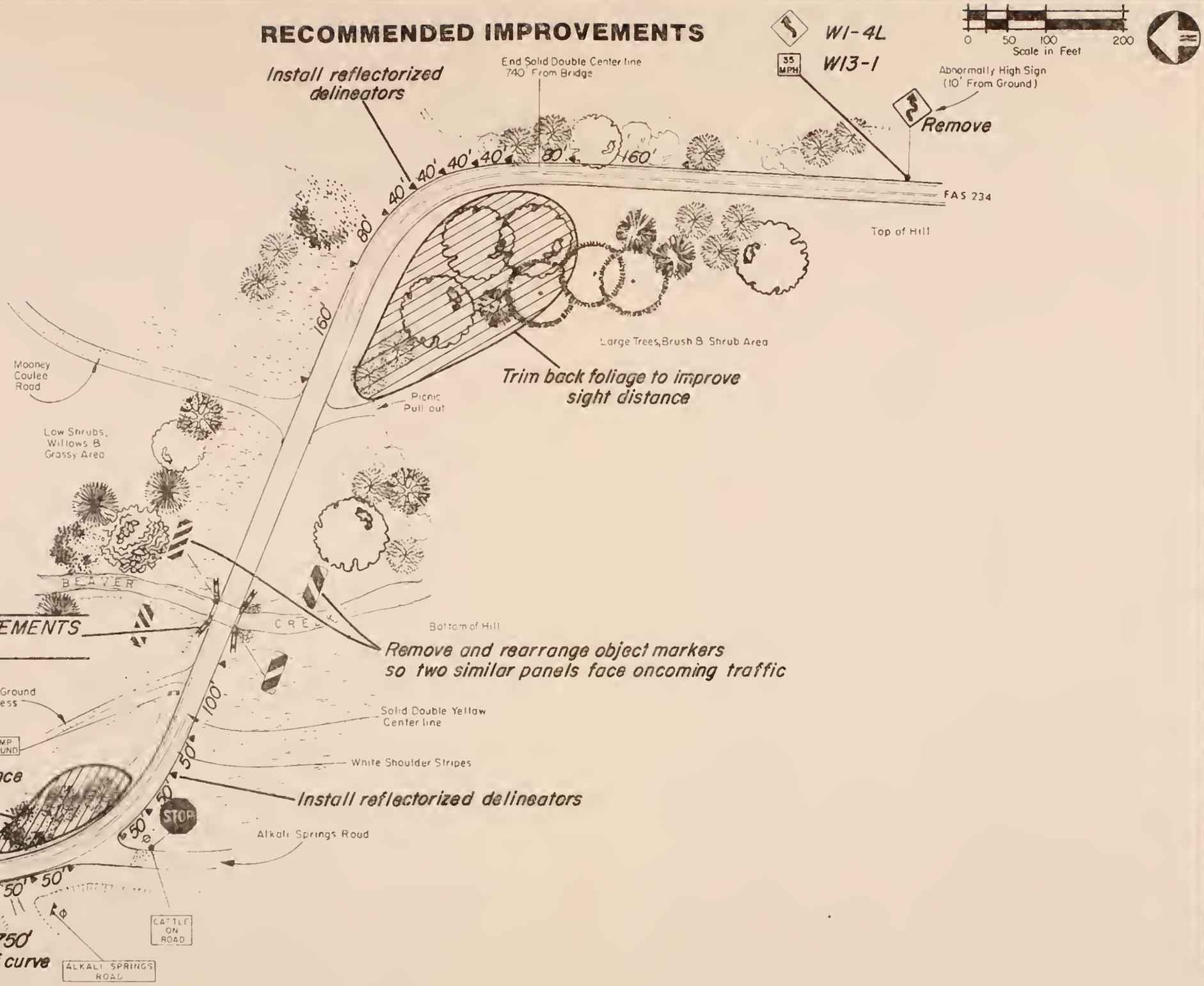
Long-Term Improvements

The bridge over Beaver Creek should be modified to prevent vehicles from going over the bank and into the water. It is recommended to extend the existing bridge guard rails 30 feet on both approaches. The presence of these guard rail sections will reduce the severity of accidents occurring on the bridge approaches.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
129	lf	Install Guard Rail	$9	$1,080

RECOMMENDED IMPROVEMENTS



BEAVER CREEK ROAD
AT MOONEY COULEE

Site No. 5

Figure No.
5-D
Hill Co.

DETERMINATION OF HAZARD INDEX

Site Number *5* Date *December, 1982*

Site Description *Beaver Creek Road at Mooney Coulee*

Indicator	Data Value		Indicator Value	Weight	Partial H.I.'s
Number of Accidents	*1.25*	acc/yr	*30*	x 0.164 =	*4.92*
Accident Rate	*17.1*	acc/MVE	*100*	x 0.225 =	*22.5*
Accident Severity	*12,020*	dollars	*68*	x 0.191 =	*12.99*
Volume/Capacity Ratio	*0.06*		*20*	x 0.082 =	*1.64*
Sight Distance Ratio	*1.20*	(wt. avg.)	*20*	x 0.074 =	*1.48*
Driver Expectancy	*2.7*	(wt. avg.)	*45*	x 0.149 =	*6.71*
Information System Deficiencies	*4.2*	(wt. avg.)	*70*	x 0.115 =	*8.05*

Hazard Index: *58.29*

Cost of Recommended Improvements: *$1,018*

Cost Factor: *94*

Priority Index = Hazard Index x .75 + Cost Factor x .25

58.29 x .75 + *94* x .25 = *67.2*

CHAPTER V
BIBLIOGRAPHY

BIBLIOGRAPHY

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Identification, Analysis and Correction of High Accident Locations, Federal Highway Administration and Missouri State Highway Commission, November, 1975.

CHAPTER VI
APPENDIX

DETERMINATION OF HAZARD INDEX

Site Number _____ Date _____

Site Description _____

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	_____ acc/yr	_____	x 0.164 =	_____
Accident Rate	_____ acc/MVE	_____	x 0.225 =	_____
Accident Severity	_____ dollars	_____	x 0.191 =	_____
Volume/Capacity Ratio	_____	_____	x 0.082 =	_____
Sight Distance Ratio	_____ (wt. avg.)	_____	x 0.074 =	_____
Driver Expectancy	_____ (wt. avg.)	_____	x 0.149 =	_____
Information System Deficiencies	_____ (wt. avg.)	_____	x 0.115 =	_____

Hazard Index: _____

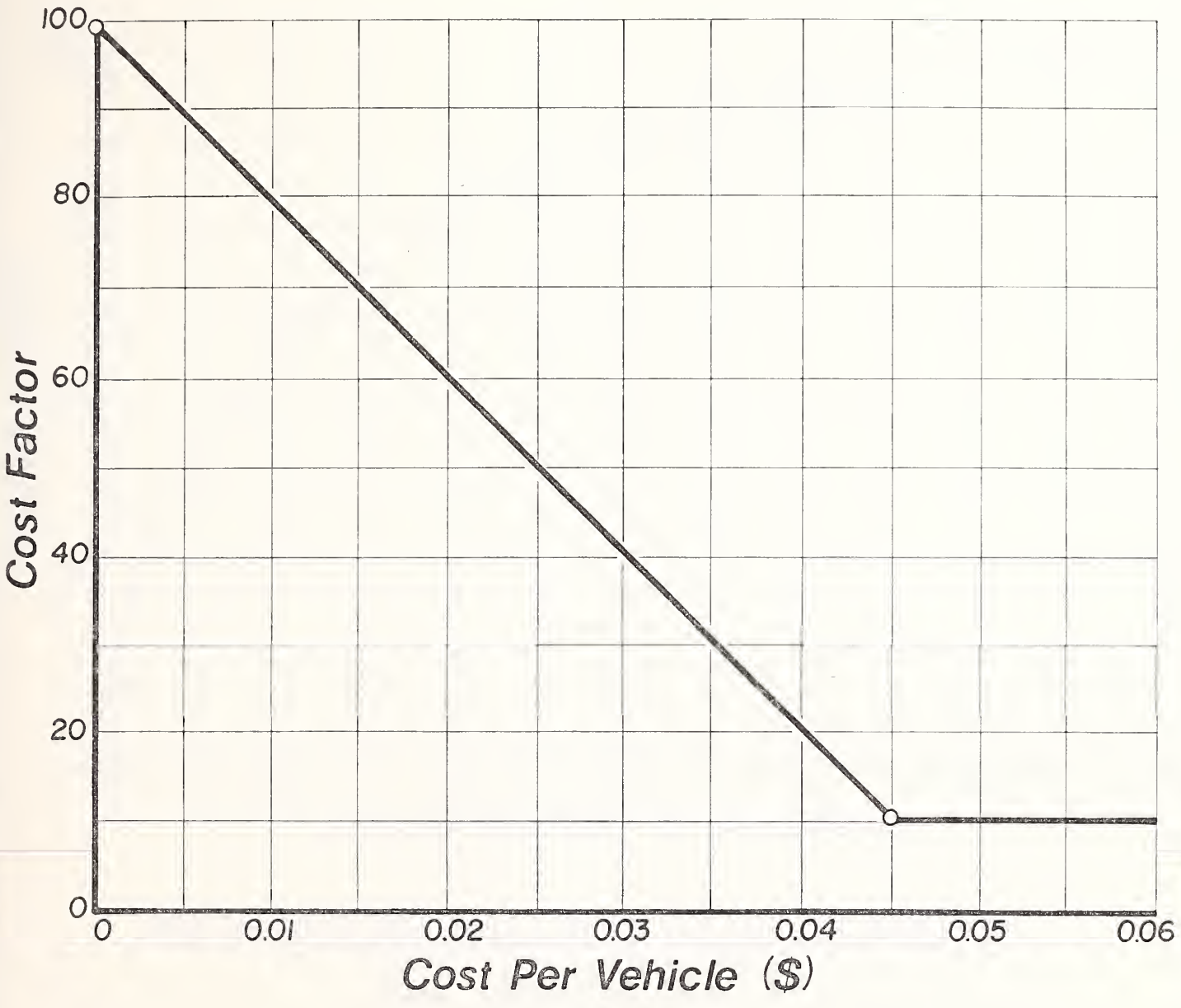
Cost of Recommended Improvements: _____

Cost Factor: _____

Priority Index = Hazard Index x .75 + Cost Factor x .25

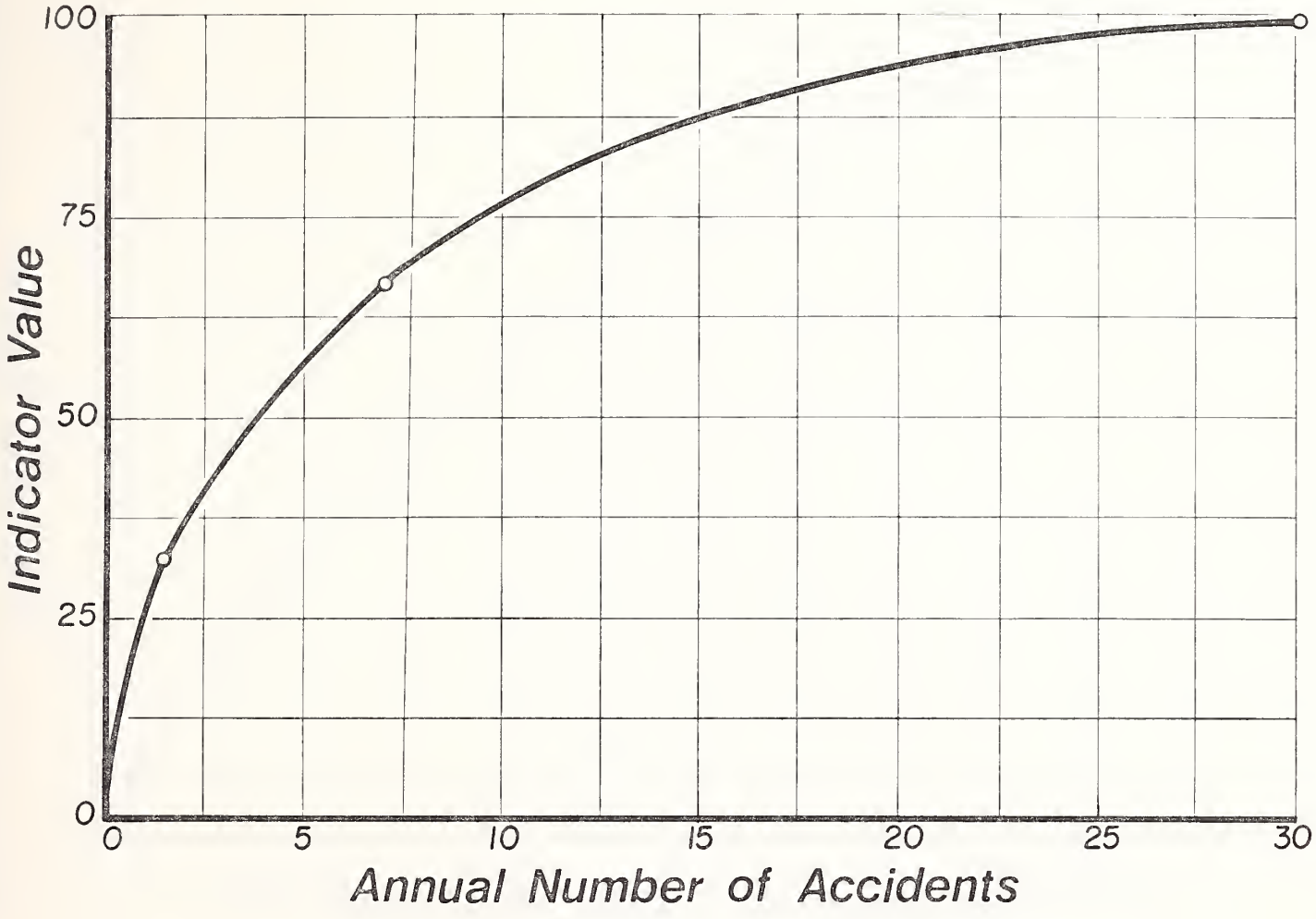
_____ x .75 + _____ x .25 = _____

FIGURE A1



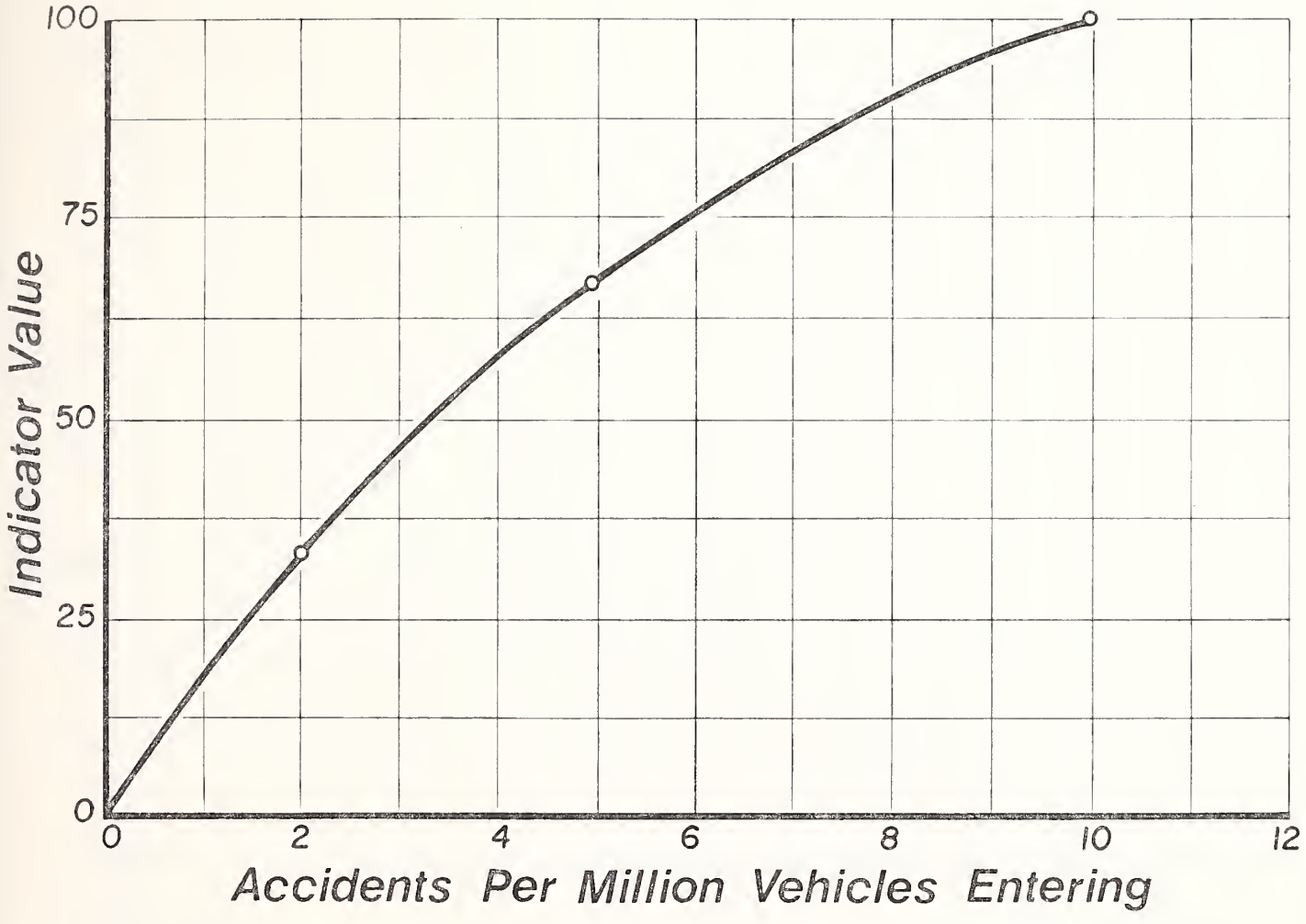
FORM FOR DETERMINATION OF COST FACTOR

FIGURE A 2



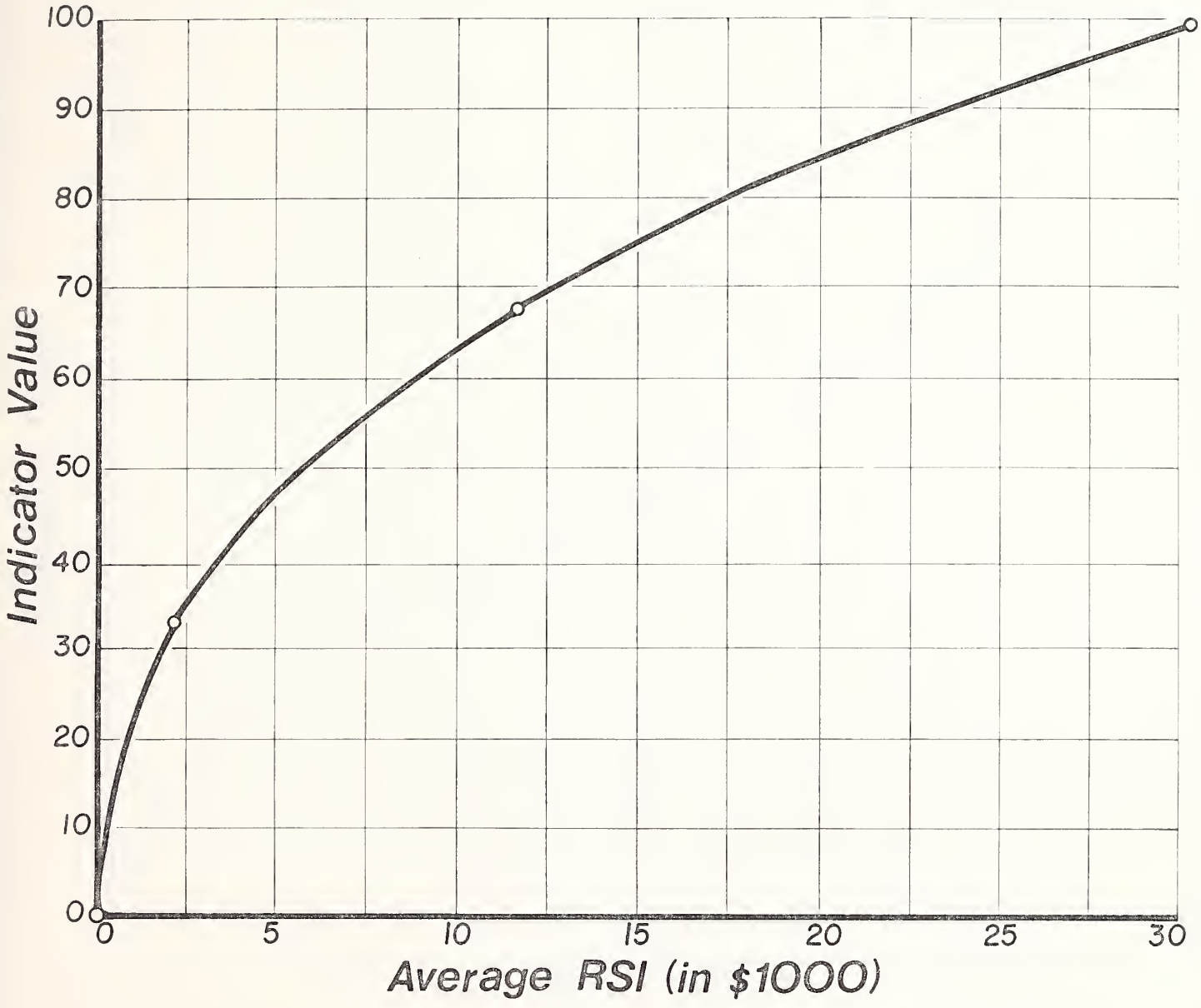
INDICATOR VALUES FOR NUMBER OF ACCIDENTS

FIGURE A3



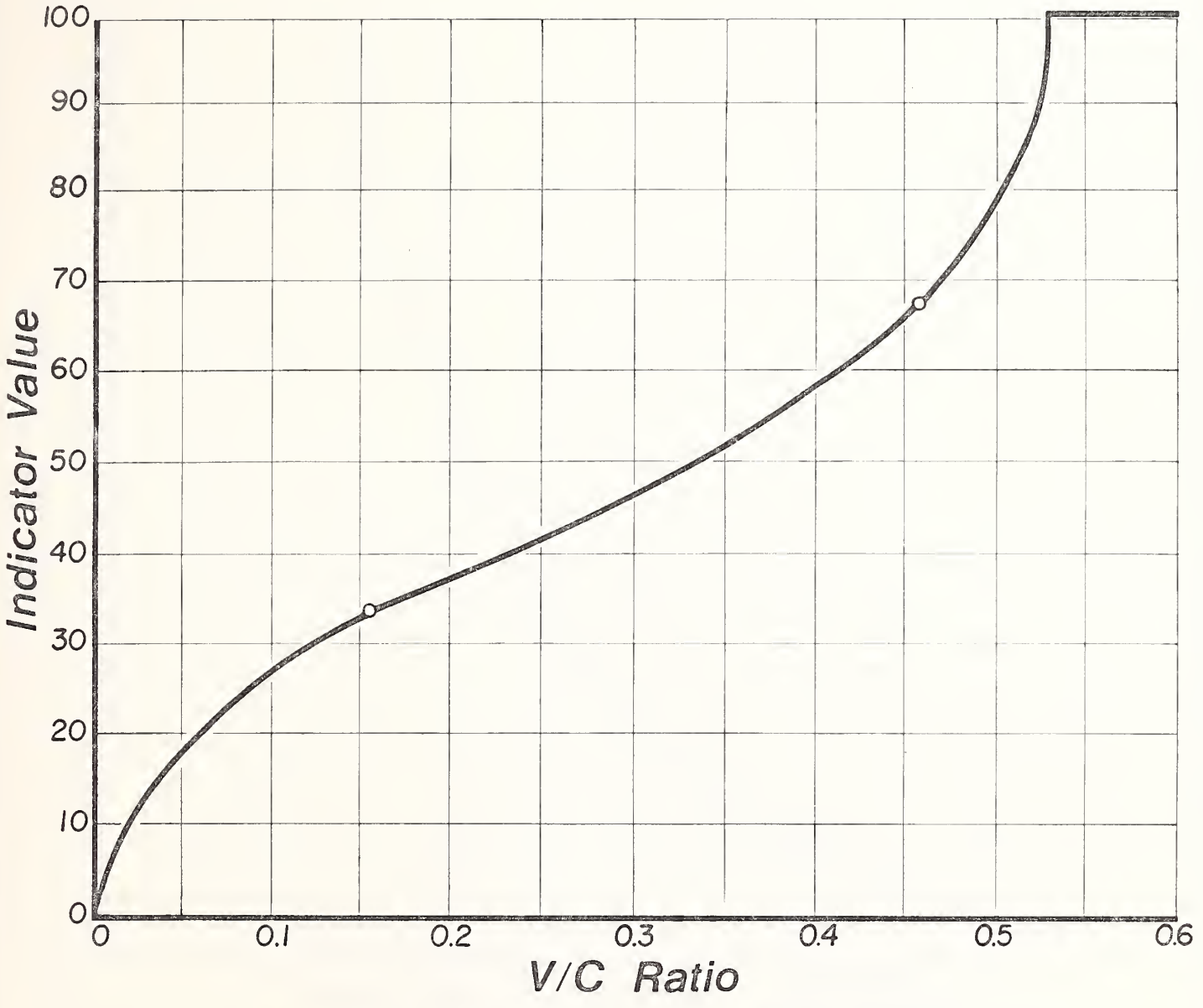
INDICATOR VALUES FOR ACCIDENT RATE

FIGURE A4



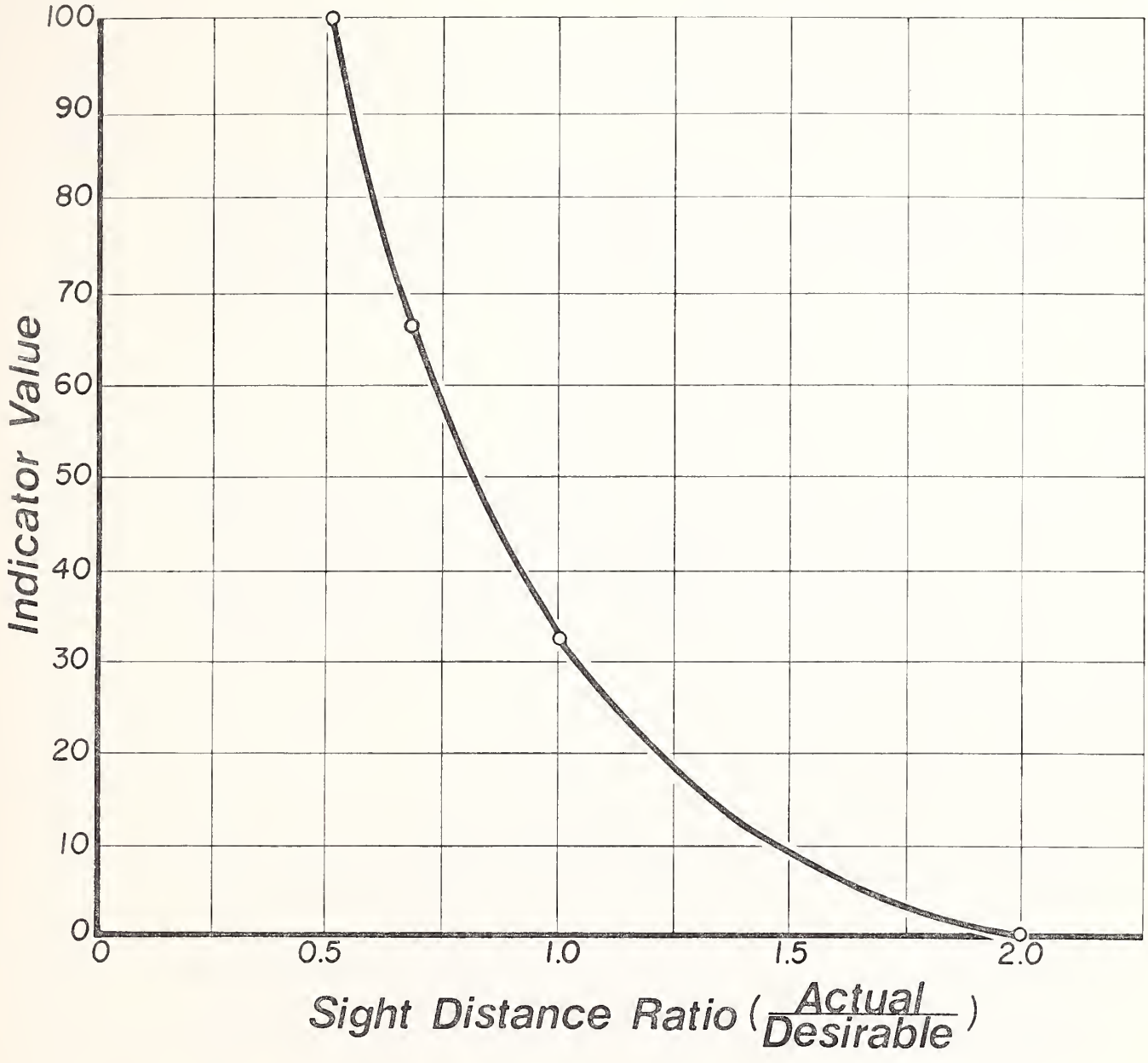
INDICATOR VALUE FOR ACCIDENT SEVERITY

FIGURE A5



INDICATOR VALUES FOR
V/C RATIO

FIGURE A6



INDICATOR VALUES FOR SIGHT DISTANCE

FIGURE A7

DRIVER EXPECTANCY PROBLEMS RATING FORM

Ratings

0 Nothing unexpected or unusual at this location.
Actions required (if any) entirely consistent with driving strategy on approach.
Standard geometry, with pathway(s) for intended movement(s) clearly evident.
No intereferences by other traffic likely.

1

2

3 Situation somewhat unexpected.
Driver must be alert, but should be able to respond adequately at "last minute" to most combinations of adverse circumstances.
Some initial confusion on intended path(s) or movement(s).
Interference from other traffic may create some degree of confusion or uncertainty for average driver.

4

5

6 Very unusual situation; will surprise many unfamiliar drivers.
Driver required to make major changes in driving tactics from those employed over past few miles.
At least a "near accident" almost expected if driver is even moderately inattentive; evasive actions likely to be required.
Intended pathway(s) confusing under fairly normal traffic or lighting conditions.
Other traffic, or lack of it, aggravates situation and misleads driver or deprives him of important cues.

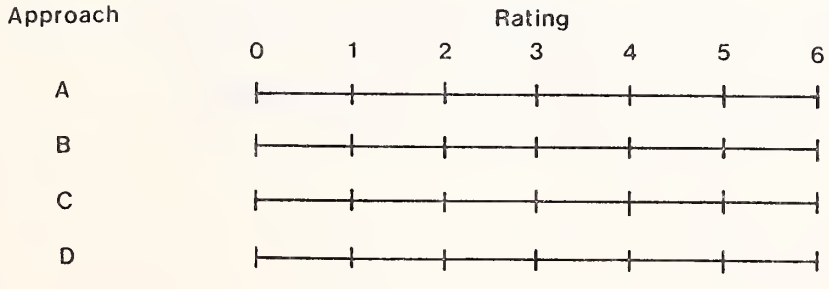
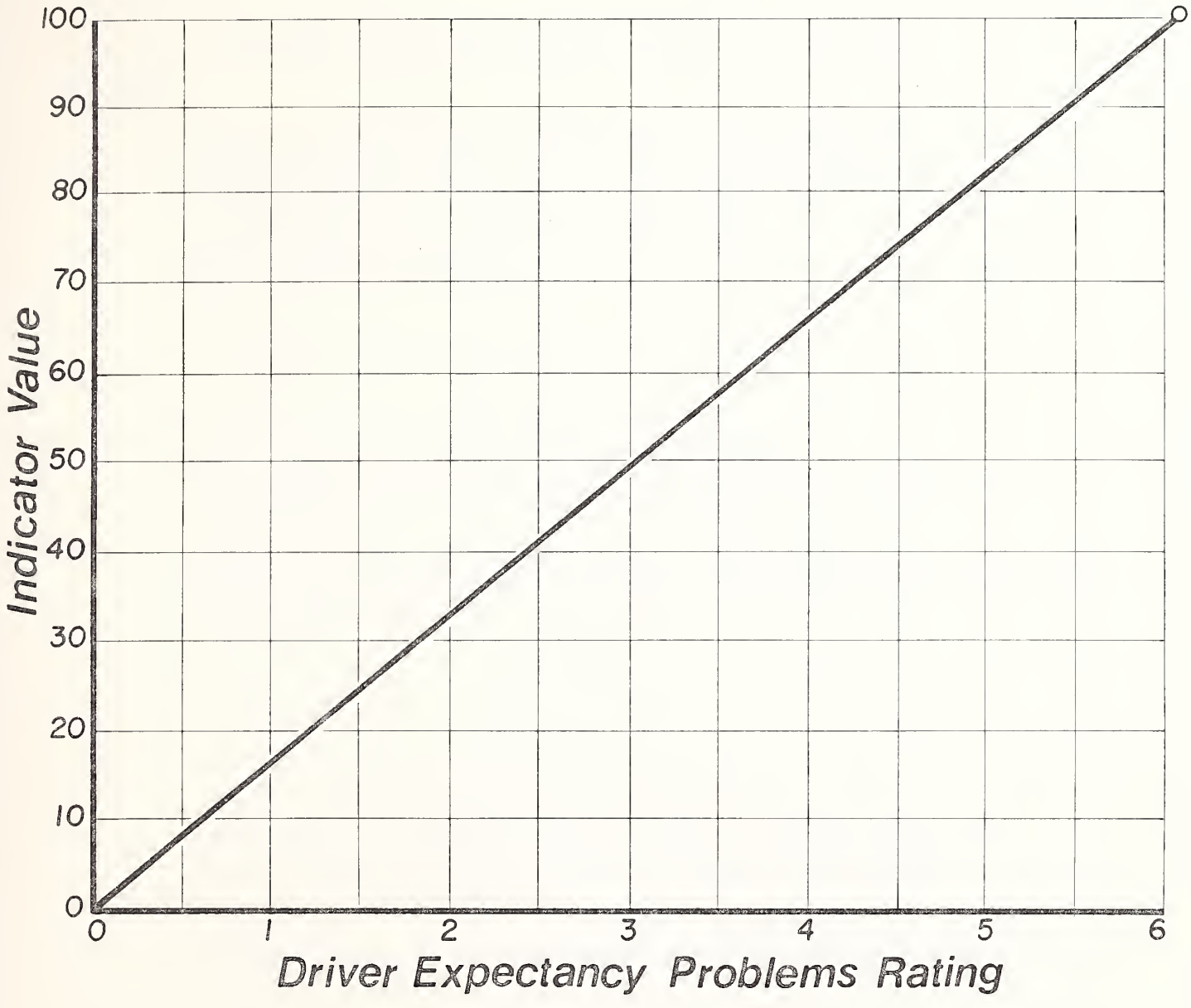


FIGURE A8



INDICATOR VALUES FOR
DRIVER EXPECTANCY

FIGURE A9

INFORMATION SYSTEM DEFICIENCIES RATING FORM

Ratings

0 Information for required decisions complete and unambiguous.
Signs, markings, delineation in good repair, clean, highly visible.
"Positive guidance" leads driver to appropriate path; makes "error" difficult.
Approach speeds of most drivers are appropriate.
Light decision load; easy and obvious.

1

2

3 Some information lacking or somewhat misleading.
Signs should be moved or augmented for better visibility or to provide more decision time.
Visibility of signs, marking, and delineation barely adequate.
Medium decision load; average driver will be able to handle situation, but may be a little uncomfortable.

4

5

6 Important information missing.
Complete new "information system" needed — design and installation.
Present signs and markings in very poor condition; need replacement.
Speed limit and/or advisory speed needed; either missing or totally inappropriate at present.
"Positive guidance" on appropriate path lacking; a clutter of negative delineation only.
Heavy decision load; complete attention of average driver required; a "tense" situation at best.

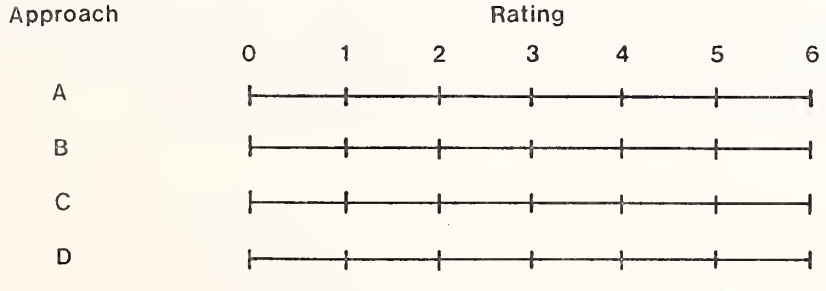
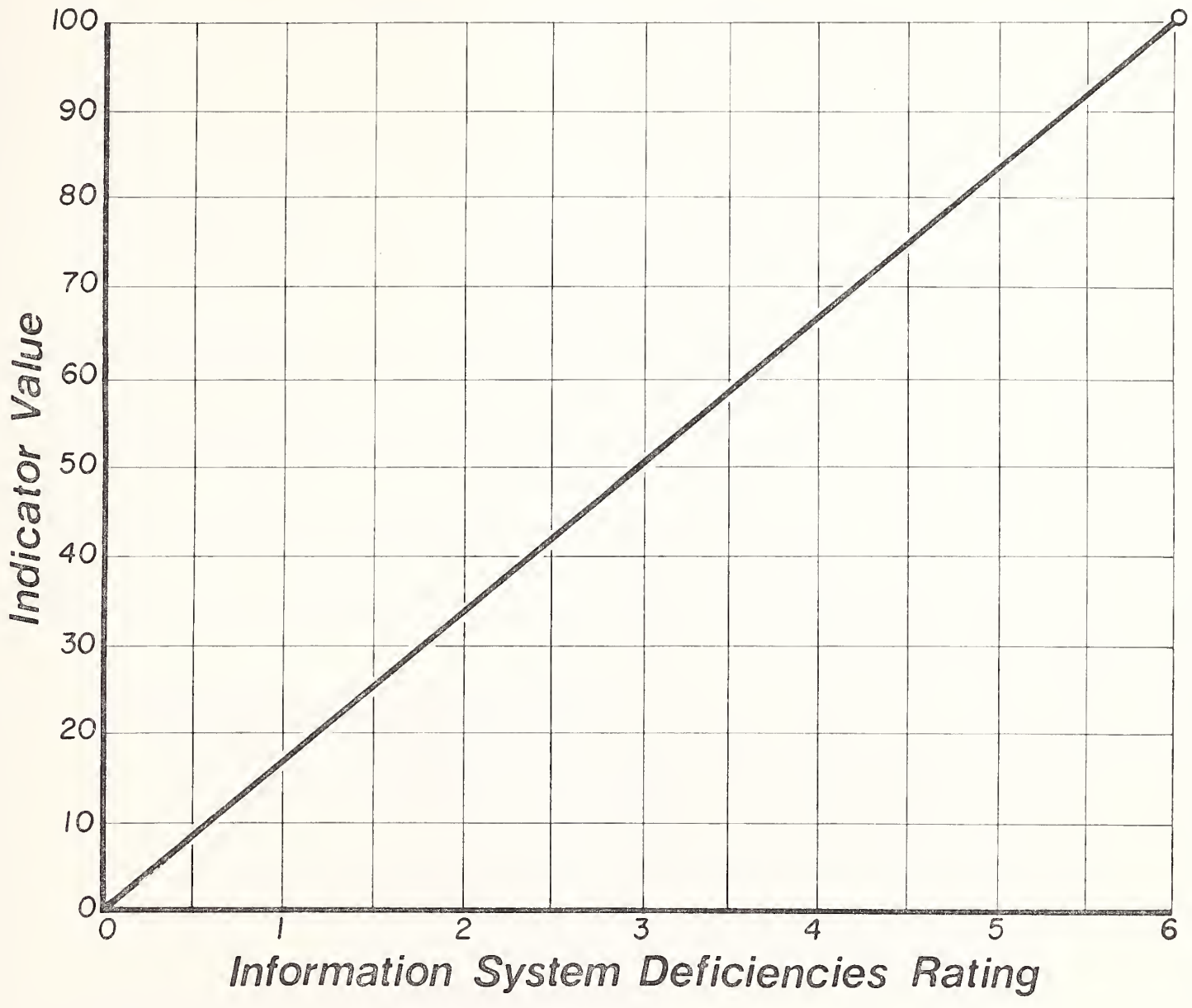


FIGURE A10



INDICATOR VALUES FOR INFORMATION SYSTEM DEFICIENCIES

FIGURE A11

BENEFIT / COST RATIO WORKSHEET

Location: _____ Milepost: _____

Improvement Description: _____

_____

Estimated Service Life _____ Years = T

Compounded Interest Rate _____ % = R

Current 19___ ADT _____

Time Frame for Accident Data: From _____ To _____ = _____ Years

I. ANNUAL COST FOR THE IMPROVEMENT:

1. C = Capital Cost for Improvement $ _____
2. K = Capital Recovery Factor = $K = \frac{R(1+R)^T}{(1+R)^T - 1}$ = _____
3. M = Change in Annual Maintenance or Operation Cost $ _____
4. Annual Cost = (C K) + M = $ _____

II. ANNUAL BENEFIT OF THE IMPROVEMENT:

1. ADT_a = Average Daily Traffic After Improvement: _____
2. ADT_b = Average Daily Traffic Before Improvement: _____
3. I/F = Ratio of Injuries to Fatalities for the Class of Highway Involved: _____
4. $\frac{Q = * + (I/F)^{**}}{1 + I/F}$ = _____ = _____ = _____

   * Current cost of a fatal accident from National Safety Council memo No. 113 = $ _____

   ** Cost of an injury accident = $_____

5. Afi = Annual average number of fatal accidents and injury accidents combined at the location which will be affected by the improvement =

   $\frac{No.}{Years}$ = _____ = _____

FIGURE A12

6. Apd = Annual Average Number of Property Damage Accidents at the Location =

$$\frac{\text{No.}}{\text{Years}} = \underline{\qquad\qquad} = \underline{\qquad\qquad}$$

7. Pfi = Expected Percentage Reduction of Fatal and Injury Accidents by Improvement =

_____ %

8. Ppd = Expected Percentage Reduction of Property Damage Accidents by Improvement =

_____ %

   a. P_1 = Largest percentage reduction in accident of any one of the improvements.
   b. P_2 = Second largest percentage reduction in accidents of any of the improvements.
   c. P_3 = Third largest percentage reduction in accidents of any of the improvements.
   d. Pfi and Ppd for location where more than one improvement will be used in combination = $P_1 + \left(\frac{100 - P_1}{100}\right) P_2 + \left(\frac{100 - P_1}{100}\right)\left(\frac{100 - P_2}{100}\right) P_3 + \ldots$

9. Annual Benefit = $\frac{ADT_a}{ADT_b}$ [Q (Afi) pfi + *** (Apd) Ppd] = _____

   *** Cost of a property damage accident = $_____

III. BENEFIT / COST RATIO = $\frac{\text{Annual Benefit}}{\text{Annual Cost}}$ = _____ = _____

FIGURE A12 (Continued)

RELATIVE SEVERITY INDEX

BY TYPE OF ACCIDENT *

	Urban	Rural
Multi-Vehicle, At Intersection		
Entering at angle	$4,300	$14,400
From same direction – both going straight	2,800	5,100
From same direction – one turn, one straight	2,500	5,100
From same direction – one stopped	3,800	5,200
From same direction – all others	2,000	6,300
From opposite direction – both going straight	4,000	20,000
From opposite direction – one left turn, one straight	4,400	15,400
From opposite direction – all others	2,700	3,800
Not stated	3,800	5,200
Multi-Vehicle, Non-Intersection		
Going opposite direction – both moving	$4,400	$19,600
Going same direction – both moving	2,900	8,100
One car parked	1,600	2,400
One car stopped in traffic	4,200	6,800
One car entering parked position	1,900	2,300
One car leaving parked position	1,200	2,700
One car entering alley or driveway	3,400	6,000
One car leaving alley or driveway	2,000	4,400
All others	1,700	7,600
Not stated	3,400	6,000
Motor Vehicle with Pedestrian, At Intersection and Non-Intersection		
Vehicle going straight	$20,000	$49,000
Vehicle turning right	13,600	11,200
Vehicle turning left	17,100	11,200
Vehicle backing	20,600	11,200
All others	14,500	11,200
Not stated	11,200	11,200

* FHWA-RD-77-87 "Identification of Hazardous Locations"

TABLE A1

Single Vehicle, at Intersection	Urban	Rural
Collision with train	$26,700	$39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jacknifed	5,200	2,000
Collision with fixed object in road	5,500	7,000
Overturned in road	9,200	7,500
Left road	5,200	12,300
Single Vehicle, Non-Intersection		
Collision with train	$26,700	$39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jacknifed	5,200	2,000
Collision with fixed object in road	6,300	9,200
Overturned in road	10,000	9,400
Left road at curve	7,600	12,400
Left road on straight road	5,200	10,500
Other One Motor Vehicle, At Intersection and Non-Intersection		
Fell from moving vehicle	$15,000	$57,200
Collision with animal	4,800	1,800
Collision with other object	4,700	4,400
All others	5,200	2,000
Not stated	3,200	3,400

TABLE A1 (Continued)